



Faculty of Resource Science and Technology

**Ethnobotanical Study of Medicinal Plants Utilised by Bidayuh Serian
(Bukar-Sadong), Sarawak, Borneo**

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**Doctor of Philosophy
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**Ethnobotanical Study of Medicinal Plants Utilised by Bidayuh Serian
(Bukar-Sadong), Sarawak, Borneo**

Anna Busang

A thesis submitted

In fulfillment of the requirements for the degree of Doctor of Philosophy

(Plant Science)

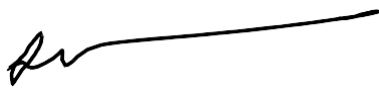
Faculty of Resource Science and Technology

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2026

DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Malaysia Sarawak. Except where due acknowledgements have been made, the work is that of the author alone. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.


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ABSTRACT

Sarawak is considered the richest state in Malaysia in terms of culture and traditional practices, with 26 major ethnic groups. Traditional knowledge, however, is on the brink of extinction for various reasons and has become a global concern. Documentation of traditional knowledge from one ethnic, namely the Bidayuh is far lacking. Therefore, this study targets the Bidayuh community in the Serian District, known as the Bidayuh Bukar-Sadong sub-ethnic group. The main objectives are to, (i) Document traditional knowledge related to medicinal plants including botanical characteristics used by the Bukar-Sadong Bidayuh, (ii) to analyze the usage and preparation methods based on survey of selected communities and interview of representative shamans, and (iii) to conduct preliminary comparison of phytochemical screening from the selected plants. Surveys have been conducted in four management zones within the Serian Division, namely Muara Tuang, Tarat, Kedup, and Tebedu. A total of 10 percent of the population from each zone was identified and randomly selected for data collection. A total of 870 respondents (aged 18 years and above) participated, with only 30.8 percent (268 respondents) willing to share knowledge about the uses of medicinal plants and their practices, and information gathered from the interview with shamans. The average age in this study is between 40–55, which also contributes to the lack of knowledge of traditional medicinal plants (55.5%). Age group, education level, and type of occupation were found to significantly influence the use of medicinal plants, while gender did not show significance. A total of 126 plant species from 104 genera and 56 plant families with medicinal value have been recorded. The Zingiberaceae family is the most abundant, with 10 species recorded, followed by Poaceae and Arecaceae, each with eight and six species respectively. More than half of the recorded plants are herbs (31%) and trees/shrubs (22%). The parts of the plants frequently used are leaves (54%) and fruits (13%). About 70 percent of the recorded plants are for external use, and only 38 species are consumed for treatment or curing diseases. 71 types of diseases or treatment associations (both medicinal and spiritual) were recorded. A total of 13 types of preparations were documented, with seven for external use and six for treating internal diseases. Conservation and the challenges in maintaining traditional knowledge were also discussed, with suggestions proposed.

Keywords: Bidayuh, Ethnomedicinal plant, fungal diseases, Sarawak, Serian,

Kajian Ethnobotani Dalam Tumbuhan Perubatan Yang Dimanfaatkan Oleh Bidayuh Serian (Bukar-Sadong), Sarawak, Borneo

ABSTRAK

Sarawak dianggap sebagai negeri terkaya di Malaysia dengan kebudayaan dan amalan tradisi dengan 26 kumpulan etnik utama. Dokumentasi pengetahuan tradisi kaum Bidayuh, walau bagaimanapun agak kurang dan masih banyak yang diperlukan. Oleh yang demikian, kajian ini mensasarkan komuniti Bidayuh di Daerah Serian yang dikenali sebagai sub-etnik Bidayuh Serian atau Bidayuh Bukar-Sadong. Objektif utama adalah untuk mendokumentasikan pengetahuan tradisi yang berkaitan dengan tumbuhan ubatan termasuk ciri-ciri botani yang digunakan oleh Bidayuh Bukar-Sadong, (ii) membuat analisa kegunaan dan penyediaan berdasarkan survei daripada komuniti terpilih dan juga temubual dengan pengamal atau bomoh, dan (iii) kajian awal perbezaan kandungan fitokimia terpilih daripada tumbuhan tertentu. Survei telah dilaksanakan dalam empat zon pengurusan dalam Daerah Serian, iaitu Muara Tuang, Tarat, Kedup dan Tebedu. Sebanyak 10 peratus daripada populasi untuk setiap zon tersebut telah dikenalpasti dan dipilih secara rawak untuk pengumpulan data. Sebanyak 870 responden (18 tahun ke atas) terlibat, dan hanya 30.8 peratus sahaja (268 responden) yang mahu berkongsi pengetahuan tentang kegunaan tumbuhan ubatan dan amalan mereka serta maklumat daripada temu bual bersama bomoh. Purata umur dalam kajian ini adalah 40–55, yang juga menyumbang kepada tiada pengetahuan dalam bidang tumbuhan ubatan tradisi (55.5%). Kumpulan umur, tahap pendidikan dan jenis perkerjaan didapati banyak mempengaruhi penggunaan tumbuhan ubatan di kalangan penduduk Bidayuh Bukar-Sadong Serian, manakala, jantina didapati tidak menunjukkan signifikasi. Sebanyak 126 spesies tumbuhan daripada 104 genus dan 56 famili tumbuhan yang mempunyai nilai ubatan oleh komuniti Bidayuh Bukar-Sadong di Serian telah direkodkan. Famili Zingiberaceae merupakan yang terbanyak, dengan 10 spesies direkodkan, diikuti oleh Poaceae dan Arecaceae, masing-masingnya dengan lapan dan enam spesies. Lebih daripada separuh tumbuhan yang direkodkan adalah kumpulan herba (31%) dan pokok/renek (22%). Bahagian tumbuhanyang kerap digunakan adalah daun (54%) dan buah (13%). Sebanyak 70 peratus tumbuhan yang direkodkan adalah untuk kegunaan luaran, dan hanya 38 spesies sahaja yang dimakan untuk tujuan rawatan atau mengubati penyakit. 71 jenis penyakit atau kaitan-rawatan (perubatan dan kerohanian) direkodkan semasa projek ini dijalankan. Sebanyak 13 jenis penyediaan direkodkan dengan tujuh untuk kegunaan luaran dan enam lagi untuk merawat penyakit dalaman. Konservasi dan juga cabaran dalam mengekalkan pengetahuan tradisi juga dibincangkan dengan cadangan dikemukakan.

Kata kunci: Bidayuh, tumbuhan ethnoperubatan, penyakit yang disebabkan fungi, Sarawak, Serian

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LIST OF ABBREVIATIONS

Bid.	Bidayuh
Bid. Ser.	Bidayuh Serian
CBNRM	Community-based Natural Resource Management
Chi.	Chinese
COVID	Coronavirus Disease
CPR	Common Property Regimes
DEA	Diethanolamine
Eng.	English
FDS	Forest Department Sarawak
FRIM	Forest Research Institute Malaysia
FRST	Faculty of Resource Science and Technology
HPLC	High Performance Liquid Chromatography
Ib.	Iban
Ind.	India
Indon.	Indonesia
IUCN	International Union for Conservation of Nature
Kpg	<i>Kampung</i> (Village)
Mal.	Malay
Mel.	Melanau
NTFPs	Non-Timber Forest Products
Pen.	Penan
SAR	Prefix name for Herbarium of Forest Department Sarawak
SBC	Sarawak Biodiversity Centre

SDMC	State Disaster Management Committee
SPE	Solid-phase extraction
Thai.	Thailand
UK	United Kingdom
UNIMAS	Universiti Malaysia Sarawak
USA	United State of America
UV	Ultra violet
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

1.1 Study Background

Medicinal plants play an important role in local community healthcare systems as the primary source of medicine for the majority of the rural population, particularly in third-world and developing countries (Shukla, 2023). Even developed and wealthy countries are beginning to recognise the value of medicinal plants as a source of healthcare. Around 12%, or more than 50,000, of the total 422,000 flowering plants recorded, are used for medicinal purposes (Schippmann et al. 2002). Schippmann et al. (2006) estimated that between 50,000 and 70,000 plant species are used in traditional and modern medicinal systems around the world.

According to Bhatt et al. (2013), more than 4.5 billion people in developing countries rely on medicinal plants as part of their healthcare. Because of the high cost of allopathic drugs and their side effects, medicinal plants are most popular in rural areas (Ekor, 2014). The global market for herbal products is estimated to be worth US \$62 billion, with a projected growth of US \$5 trillion by 2050. (WHO, 1999).

The majority of medicinally derived drugs were discovered through the study of traditional cures and indigenous knowledge. Many indigenous and traditional people live in tropical rainforests. Indigenous communities around the world have extensive knowledge of the natural resources on which they rely directly for a living (Bansal et al., 2023). Indigenous people make up 4% of the global population (United Nations, 2023 onwards), and they have the most diverse collection of traditional knowledge (Hossain & Ballardini, 2021). This traditional knowledge is a global treasure that is typically passed down through generations

via oral expressions and practises. Regrettably, this practice is dwindling (Kulip, 2003, 2010). There is an urgent need to record and preserve our valuable knowledge of wild jungle plants, particularly those with medicinal uses. The forest habitat is being degraded and depleted at an alarming rate. Furthermore, the indigenous medicinal men (manang or bomoh) who possess the knowledge do not pass it on to future generations, who are either uninterested or rely on modern medicines (Chai, 2006).

The global population is approaching five billion, and at this rate of growth, it will likely reach 7.5 billion by the end of 2020 (European Union, 2022 onwards). According to global estimates, more than 34 per cent of the world's 5 billion people cannot afford the products of the Western pharmaceutical industry and must rely on traditional medicines derived primarily from plants. This information was compiled by WHO (1999, 2006, 2007, 2009, 2010) in an inventory of medicinal plants that included over 20,000 species.

There are approximately 14,500 flowering plant species in Malaysia with 1,300 medicinal plant species recorded in Peninsular Malaysia alone (Burkill, 1935). Borneo is thought to have around 15,000 plant species (Ng, 1995). In Sabah, 7,411 plant species (excluding Bryophyte, algae, and fungi) have been identified. All the plants have been used for medicinal purposes, food, supernatural elements, rituals, and a variety of other purposes (Kodoh et al., 2017).

1.2 Rationale of the study

Traditional knowledge is in danger of extinction as a result of habitat degradation, overexploitation, and a lack of interest on the part of younger generations in passing on this knowledge and its associated practices. Traditional medicinal plant knowledge is a legacy passed down from generation to generation, and some of it is being lost due to the increasing rate of habitat destruction. There is no literature on the Bidayuh Bukar-Sadong

communities's use of ethnomedicinal plants in the Serian Division. Bidayuh is the most widely spoken dialect and one of the Serian Division's earliest communities.

As a result, the focus of this study was on medicinal plants used by the Bidayuh Bukar-Sadong Communities in Serian Division. The research is aimed at determining which plant parts are used, which diseases are treated, and how they are prepared and administered. Preliminary screening of two major compounds in plants; flavonoid and alkaloid was also conducted. The medicinal plants were chosen based on the following criteria: (1) plants used by four zones; and (2) plants used to treat the same diseases (skin disease).

1.3 Objectives

This project was conducted to study the medicinal plants by the Bidayuh community of the Serian Division with specific objectives as follows:

- i. To document the medicinal plants including botanical characteristics used by the Bidayuh Bukar-Sadong communities in Serian.
- ii. To analyse the uses and preparation of the selected medicinal plants based on survey of selected communities and representative shamans of the Bidayuh Bukar-Sadong communities in Serian.
- iii. To conduct a preliminary comparison of screening phytochemical in selected plants used by the Bidayuh Bukar-Sadong communities in Serian.

1.4 Research Questions

This study focuses on the Bidayuh Bukar-Sadong communities in the Serian Division, to find out the use of medicinal plants in their daily lives. However, before the research was conducted, there were several questions related to the scope and objectives to be achieved.

Among these questions were:

- i. What medicinal plants are used by the Bidayuh Bukar-Sadong communities in Serian, and how are these plants integrated into their traditional healing practices?
- ii. How are the levels of traditional knowledge related to medicinal plants by the Bidayuh Bukar-Sadong in each study zone, and what is the willingness of the community to share this knowledge?
- iii. How are selected medicinal plants prepared and utilized by the Bidayuh Bukar-Sadong communities in Serian, and what are the cultural, ecological, and pharmacological factors influencing their preparation methods and therapeutic applications?
- iv. How much knowledge do the people have about the parts, functions, and activities of plants?
And,
- v. Are the traditional practices and knowledge of medicinal plants among the Bidayuh Bukar-Sadong community influenced by demographics (gender, age, educational level, and occupation)?

1.5 Study Limitation

Conducting this survey was challenging because not all knowledgeable practitioners of traditional medicine were willing to participate. Even those who knew about medicinal plants were often difficult to convince. A key difficulty was the lack of prior documentation or established protocols for engaging with traditional healers, specifically among the Bidayuh Bukar-Sadong. This is a common issue not only in Sarawak but also in other parts of the world, as noted by various researchers (e.g. Omar & Latip, 2022; Yasir, 1987; Lyamuya et al. 2023; Punchay et al. 2020).

CHAPTER 2

LITERATURE REVIEW

2.1 Ethnobotanical Study

Plants have been used by humans for thousands of years to provide food and medicine, shelter (materials for construction and manufacture of crafts and tools), and other products such as fuel, textiles, dye, poison, and so on, as well as to be used in ritual ceremonies. Non-timber forest Products (NTFPs), which include ethnobotanicals, were considered less economically important before the 1980s when timber extraction and synthetic oil-based products replaced forest minor products (Alexiades & Shanley, 2004). However, it gained prominence in the late 1980s with the introduction of Common Property Regimes (CPR) and Community-Based Natural Resource Management (CBNRM). Furthermore, as technology advanced, humans became more interested in the chemical and genetic properties of plants for human benefit. It was made possible by ethnobotanical studies, which provided us with a wealth of information and data about plants, both useful and harmful (Sills et al., 2011).

Ethnobotany is defined as "the science of people's interactions with plants" (Turner et al, 2000). John William Harshberger coined the term ethnobotany in 1896, after conducting extensive ethnobotanical research in North Africa, South America, and Scandinavia in the early twentieth century. Even by the narrowest definition of the discipline, the definition and scope of ethnobotany have remained remarkable. This is an interdisciplinary science that studies the relationship between humans and plants in linguistics, education, healing, nutrition, archaeology, paleology, resource tenure and management, livelihood, and other areas. As a result, ethnobotany can serve as a gateway to many other disciplines.

2.1.1 Plants as Traditional Medicine

Since ancient times, plants have been used to treat various diseases (Chah et al., 2006). Plants are recognised as a significant source of medicinal preparations, as well as many drugs derived from herbal plants (Boy et al. 2018, Miller, 2001). Plants are responsible for approximately 25% of all drugs (Rates, 2001). For thousands of years, plant-derived drugs have been a part of the evolution of human healthcare. Plant-based medicines were widely used in India and China (Shukla, 2023). Plants are currently being used as part of routine health care in Asia and India (Sri Astutik & Kimengsi, 2019).

Medicinal plants are one of the most promising natural sources that have been used as traditional medicine by the local community. Most medicinal plants are herbs, shrubs, and trees found in forests, orchards, and backyards (Kodoh et al., 2017, Meijaard et al. 2013, Kulip 1997). Local communities used approximately 80% of the indigenous plants, and approximately 1,200 were used for medicinal purposes statewide (Kulip, 2003; Kulip et al., 2010). The Malaysian Forest Research Institute (FRIM) has identified over 1000 Malaysian plants with medicinal potential. Yusof (2013), on the other hand, has compiled and provided notes on 665 species of medicinal plants in Malaysia. This demonstrates that the number of medicinal plants is decreasing over time. While Chai (2006) documented nearly 700 species used by ethnic communities in Sarawak.

The study of traditional plant knowledge is an essential aspect of medicinal plant research. Since time immemorial, humans have been able to heal themselves using traditional herbal medicines and ancient remedies. Humans have found solutions within their environment and have adopted various strategies based on climatic, phytogeographic, and faunal characteristics, as well as unique culture and socio-structural typologies. Traditional healers pass on the majority of their knowledge to future generations through oral

communication and discipleship practice. According to the World Health Organization, approximately 80% of the world's population relies on traditional medicine to treat ailments (Said et al., 2002). Plants play an important role in disease treatment and continue to be the preferred option for the vast majority of people (Adiaratou et al., 2005).

Even Asia, the Middle East, and other regions were practising herbal treatments for drug addiction control. Plants that are commonly used for medicinal purposes are those belonging to the families of Annonaceae, Apocynaceae, Arecaceae, Dioscoreaceae, Ebenaceae, Euphorbiaceae, Flacourtiaceae, Lauraceae, Menispermaceae, Myrsinaceae, Myrtaceae, Rubiaceae, Rutaceae, Simaroubaceae, Thymelaceae and Zingiberaceae (Soepadmo, 1991; Henry & Schneiter, 2009) and Costaceae, Fabaceae, Rhamnaceae, Moraceae, and Melastomataceae (Henry & Schneiter, 2009). Diseases that can be cured by medicinal plants, as reported, are fever, pain in the bones, stomach ache, nausea, cough, sore eye, antidote (snake bite, scorpion bite), boils, cuts, and wounds, and many others (Chai, 2006; Henry & Schneiter, 2009; Ravichandran et al. 2023; Rakotoarivelo et al. 2015).

2.1.2 Food

Many plant parts, such as flowers, fruits, nuts, and young shoots, vary in colour, smell, and texture, and they are important sources of vitamins, trace elements, proteins, and fats (Sills et al., 2011). These plant parts were collected by ancient people thousands of years ago before agriculture began, and they are still collected today for the same purposes, as food (Sageng et al. 2022, 2024)

Plants are commonly used as food, and Chai (2006) has compiled a long list of forest plants that are consumed as vegetables and fruits. Common food is from the family of Clusiaceae, Sapindaceae, Moraceae, Euphorbiaceae, Malvaceae, Musaceae, Fagaceae (fruit

edible after cooking), Tiliaceae, Clusiaceae and Arecaceae (edible fruit), Euphorbiaceae, Poaceae (staple food), Euphorbiaceae (traditional beverage), Solanaceae, Zingiberaceae (shoots), Costaceae, Cecropiaceae, Verbenaceae and Cucurbitaceae (vegetables), Arecaceae (cabbage for food) (Henry & Schneiter, 2009).

2.1.3 Ritual and Mystical Purpose

The relationship between plants and human dates back thousands of years. They used the plants for food, shelter, and defence. Many ethnic or indigenous peoples around the world believe that certain plants are good omens while others are bad. For example, Rana et al. (2016) reported that many tribes in South Rajasthan, India, used about 31 plant species for ritual ceremonies. However, documentation on the use of plants for ritual and mystical purposes is rare in Malaysia. Henry and Schneiter (2009) identified four plant families that are commonly used for ritual and mystical purposes by the local people such as Myrsinaceae, Lauraceae, Salicaceae (previously classified as Flacourtiadeae), and Zingiberaceae.

2.1.4 Construction

The use of ethnobotanical resources in construction is an age-long practice that dates back to ancient times. These plants, with their vast array of benefits, have been used for various purposes such as building materials, ropes, and textiles, among others. Among the plant families popularly used for constructions in Southeast Asia are such as Fabaceae, Sapotaceae, Rosaceae, Dipterocarpaceae, Lauraceae, Apocynaceae, Anacardiaceae, Sapindaceae and Magnoliaceae (Henry & Schneiter, 2009). Other families are Olacaceae and Fabaceae (Henry & Schneiter, 2009).

One example of ethnobotanical plants employed in construction is the bamboo. Bamboo is an eco-friendly alternative to wood and steel (Jayanetti & Follett, 2008). With

its exceptional strength and elasticity, bamboo has become a popular choice for building scaffolding, floors, walls, and roofing. In addition to its strong structural properties, bamboo also grows incredibly fast, making it a sustainable choice for construction materials (Manandhar et al., 2019).

2.1.5 Spices and Flavouring Agents

Spices and flavouring agents are among the most fascinating crops used by humans, with a long history. Spices and aromatic plants are revered in all civilizations, and many were likely used as offerings to gods. Among the civilizations, it was the Indians and Chinese who gradually developed profound knowledge in the use of plants and plant products for the treatment of ailments. One of the goals of all circumnavigations and great explorations during the Renaissance was to find the spice land. Spices were as sought after as gold and precious stones (Ravindran et al., 2007).

Spices and flavouring agents are used as condiments in the preparation of a wide range of dishes, including vegetables, meat, and fish. Spices add flavour, aroma, and colour to foods and beverages. Begoniaceae, Fabaceae, Flacourtiaceae, Gnetaceae, Lauraceae, Myrtaceae, Olacaceae, and Zingiberaceae are some of the most commonly used plant families (Henry & Schneider, 2009).

2.1.6 Others

Tropical native aquatic plants, which can be used in phytoremediation mainly for the removal of colour and Chemical Oxygen Demand (COD) from pulp and paper mill effluent, the percentages of colour removal for the three tropical native plants, *Scirpus grossus* L. f., *Azola pinnata* R. Br., and *Salvinia molesta* Mitchell, were 50.28%, 43.09%, and 49.72%, respectively. For COD removal, all three plants successfully removed 100% COD. From the

results, the best tropical native aquatic plant to remove colour and COD from pulp and paper mill effluent is *Scirpus grossus*.

Other ethno-plant applications include traditional tools (Rubiaceae, Loganiaceae, Polygalaceae, Dipterocarpaceae, Sapotaceae), non-timber forest products (Thymelaeaceae), traditional handicrafts (Sterculiaceae, Pandanaceae), fruit and bark as firewood (Sapotaceae), root used to repel pests (Gnetaceae), latex as glue (Euphorbiaceae and Apocynaceae) perfumes and fragrances (Annonaceae, Araceae, Clusiaceae, Lauraceae, Piperaceae, and Zingiberaceae) - parts used: flowers, rhizomes, seeds, bark, leaves, the whole plant, or the stem (Henry & Schneider, 2009). Plants can also be used as shampoo and soap. To make shampoo, the dried rinds are pounded, wetted with a small amount of water, and applied to the hair.

The fleshy seeds of *Pagium edule* Reinw. are smoked, pounded and mixed with a little water before being used as soap. The family of plants that are commonly used as shampoo and soap are Actindiaceae, Aquifoliaceae, Dipterocarpaceae, Flacourtiaceae, Lamiaceae, Linaceae, Polygalaceae and Thelypteridaceae (Henry & Schneider, 2009). Enhancing the smell sense of dogs (Fabaceae), shining agent (Begoniaceae and Byttneriaceae), as a fermenting agent (ragi) in producing alcohol (Lauraceae), blowpipe poison ingredient (Moraceae), to make knocker (talun) (Olacaceae and Rubiaceae) to stop the effects of alcohol (Zingiberaceae), to make straps, strings (Annonaceae and Sterculiaceae), animal traps (Annonaceae), sandpaper (Dilleniaceae), fire starter and wrappers (Arecaceae), fish poison (Smilacaceae) and mosquito repellent (Annonaceae) (Henry & Schneider, 2009).

2.2 Existing Studies on Medicinal Plants in Malaysia

Traditional Knowledge of a Practitioner in Medicinal Plants of Masjid Ijok Village, Perak, Malaysia reported a total of 50 plant species belonging to 36 families with medicinal uses were recorded (Ramli et al., 2015). Herbs constitute 38% of the plant species used. This was followed by shrubs (30%) and trees (28 %). Leaves are the most common plant part used in preparing herbal medicine. More plants are used in gastrointestinal problems than others.

The Semai, *orang asli* at Kampung Batu 16, Tapah Perak, Malaysia shows that a total of 37 species were recorded of which most of the species are native (Ong et al., 2012). The status of medicinal plants is given as one of the three categories, wild, planted or both wild and planted. These 37 species are in 36 genera and 30 families. This shows that these villagers use a wide variety of plant taxa for medicinal purposes.

The majority of the *orang asli* of Kampung Buluh Nipis are still dependent on local plants as their primary source of medication (Das et al., 2012). The field survey indicated that there are 10 commonly used medicinal plant species and four herbal treatments are used in daily life. Most of these species grow in the wild nature and their medicinal properties are crucial in the traditional medicine of the *orang asli*. The majority of the species reported are widely known through peninsular Malaysia and are employed for a large number of medical conditions.

A total of 56 species of medicinal plants with various were recorded and used by the Temuan villagers in Kampung Jeram Kedah, Negeri Sembilan, Malaysia (Ong et al., 2011). Most of the species are native plants that are collected from the jungle near the village for use when needed. Very few species are cultivated plants such as *Aloe vera* (L.) Burm. f., *Carica papaya* L., *Cocos nucifera* L., *Psidium guajava* L. and *Zingiber spectabilev* Griff.

The plants are used to treat many types of ailments ranging from simple ones such as joint aches and pains to serious ailments such as diabetes, malaria and tumours. The most frequently used plant part was the root, followed by the stem, leaf, whole plant, root and leaf, fruit, inflorescence and rhizome. The common mode of administration is oral with a total of 38 species, used externally with a total of 12 species, while six species are used both externally and internally. The decoction is the most common method of preparing medicine to be taken orally.

Traditional Knowledge of Medicinal Plants among the Malay villagers in Kampung Mak Kemas, Terengganu, Malaysia recorded a total of 56 species of medicinal plants (Ong et al., 2011). A majority of these species are herbaceous angiosperms followed by trees and shrubs. The most common part of the plant used in preparing herbal medicine is the leaves. Most plants are used for general health, to treat dermatological complaints, reproductive systems, abdominal problems and fever compared to other ailments. A similar study in Kampung Tanjung Sabtu, Terengganu, Malaysia shows that a total of 52 species of medicinal plants were recorded (Ong et al., 2010). The 52 plant species of medicinal plants belong to 31 families and 49 genera. Out of the total number of medicinal plants, 51 species are angiosperms, while one species is a Pteridophyte. Ethnomedicinal survey of plants used by the *orang asli* in Kampung Bawong, Perak West Malaysia shows that the majority of the *orang asli* are still dependent on local plants as their primary source of medication (John et al., 2010). Sixty-two medicinal plant species are belonging to a total of 36 families. Most of these species grow in nature and their medicinal properties are crucial in the traditional medicinal of the *orang asli*.

Research on medicinal plants of the Malay community in Kota Samarahan District, Sarawak recorded 54 species from 31 families of medicinal value plants (Tawan et al., 2010).

Of the 31 families, the family Euphorbiaceae was represented by six species, the family Asteraceae with five species and Fabaceae with four species. These medicinal plants are used to treat common illnesses or diseases such as antidotes for snake bites, asthma, diarrhoea, fever, flu, headache, hypertension, rheumatism, stomach ache, skin disease, toothache and ulcer.

Similar research on the Iban community in Sabal District, Sarawak collected and identified 62 species from 36 families of vascular plants (Abdul Gani, 2003). Most of the medicinal plants were used for treating rheumatism, bone fractures, sore throat, diarrhoea, fungal infections, cough, asthma and others. Out of 62 species, fifteen species were identified as the common and most frequently used for medicinal purposes among the communities. These species were *Agrostistachys leptostachya* Pax & K. Hoffm., *Andrographis paniculata* (Burm. f.) Wall ex Nees, *Blumea balsamifera* (L.) DC, *Cassia alata* (L.) Roxb., *Croton coriifolius* Airy Shaw, *Eurycoma longifolia* Jack, *Lindera pipericarpa* Boerl., *Ocimum basilium* L., *Scoparia dulcis* L., *Parkia timoriana* (DC) Merr., *Plectomiopsis geminiflorus* (Griff.) Becc., *Psilobium* spp., *Psychotria calocarpa* Kurz, *Zingiber porphyrosphaera* K. Schum. and *Zingiber officinale* Roscoe.

Kadazandusun communities around Crocker Range used 50 plant species for medicinal purposes (Fasihuddin & Ismail, 2003). The plants include those used for common afflictions such as minor wounds, skin diseases, diarrhoea, fever, coughs and malaria. The most commonly used are *Blumea balsamifera* (for fever), *Cassia alata* (for skin diseases), *Centella asiatica* (L.) Urban (for stomachache), *Gendarusa vulgaris* Nees (for general malaise), *Nicotiana tabacum* L. (as insect repellent), *Psidium guajava* (for diarrhoea), *Phyllanthus niruri* L. (for malaria), *Tinospora crispa* (L.) Miers ex Hook. f. & Th. (for hypertension) and *Zingiber officinale* (for rheumatism).

Other related publications include the ethnobotany of the Iban and Kelabit (Christensen 2002), medicinal plants (Chai, 2006), utilization of ethnomedicinal plant by Kenyah ethnic (Khan et al., 2023), and, indigenous knowledge of medicinal plants used and their implication towards health-seeking behaviour among the Melanau in Pulau Buit, Sarawak Malaysia (Awang Kassim et al., 2016), in Mukah by Omar and Latip (2022), and medicinal plants usage of Jagoi Bidayuh community, Bau District by Baling et al. (2017) and Campbell and Mikeng (2019) on the plants and spiritual. Jawol et al. (2018) on indigenous knowledge among Iban Kua' in Samarahan also include on traditional healing practices using plant in their documentation, and, Sait et al. (2018) for the Iban community in Baling (Sri Aman) and Bidayuh of Padawan.

2.3 Administration of Medicinal Plants

The plants were used in various ailments in the form of powder, paste and raw form (Abat et al. 2017). Different types of preparation made from medicinally important plants included decoction, juice, powder, paste, oil and whole plant extract (Rashid et al. 2021; Saini & Charmkar, 2013). The most common method of preparation is a poultice, followed by decoction and infusion (Ong et al., 2011; Ramli et al., 2015). Thus, more medicinal plants are used topically than orally (Ong et al., 2011).

According to Baling et al. (2017), the preparation of medicinal plants for most communities in Sarawak is almost similar, if the plant has the same function or use. For example, the use of Areca nut (*Pinang*) to treat wounds or boils. The Areca nut will be sliced or crushed together with *Piper betle* (*Sirih*), when crushed, the mixture will be applied to the wound or boil area. This method also similar as reported by Chai (2006) for the Iban and Selako, Jackson et al. (2006) for the Iban in Bintulu, and Omar and Latip (2022) for Melanau Mukah. As for the use, most of the plants use in medicinal practices

are almost similar. The source of knowledge, especially exotic plants, is obtained from external sources (Medeiros et al., 2017).

2.4 Phytochemical Studies of Medicinal Plants in Malaysia

Malaysia is renowned for its rich biodiversity, housing a plethora of medicinal plants that have been utilized for centuries by indigenous communities and traditional healers. The phytochemicals found in these plants play a critical role in their medicinal properties, offering a natural alternative to synthetic pharmaceuticals. Phytochemicals are bioactive compounds produced by plants that contribute to their color, flavor, and disease resistance. These compounds can be classified into various categories, including alkaloids, flavonoids, terpenoids, and phenolic compounds. Many phytochemicals possess antioxidant, anti-inflammatory, and antimicrobial properties, making them valuable in treating various ailments. The exploration of these compounds is crucial in understanding the therapeutic potential of Malaysian medicinal flora.

The use of medicinal plants in Malaysia is deeply rooted in the culture of its diverse ethnic groups, including the Malay, Chinese, and indigenous communities. Plants such as *Andrographis paniculata* (known as *Hempedu bumi*) and *Curcuma longa* (*Kunyit*) are commonly used to treat conditions like fever, inflammation, and digestive issues. Phytochemicals are chemical compounds that occur naturally in plants (*phyto* means “plants” in Greek). Some are responsible for colour and other organoleptic properties, such as the deep purple of blueberries and the smell of garlic. Phytochemical significance, but are not established as essential nutrients (USFDA, 2024 onwards). The assortment of plant samples for phytochemical screening is largely based on the ethnic uses of plants. The ethnobotanical approach is essentially one of several methods that are practical in selecting plants for biological screening in a drug discovery programme (Jantan, 2004). Numerous

studies have identified the phytochemical constituents of various medicinal plants in Malaysia. For instance, *Hempedu bumi* is rich in diterpenoids, particularly andrographolide, which exhibits potent anti-inflammatory and antiviral activities (Liew et al., 2020). Similarly, *Kunyit* contains curcumin, a compound known for its anti-cancer and anti-inflammatory properties (Lee et al., 2013). These findings underscore the significance of phytochemicals in enhancing the therapeutic efficacy of these plants.

During the early years of medicinal plants, research focused basically on phytochemical studies in the direction of isolation of pure new compounds from particular medicinal plants and their structural elucidation. Most phytochemical studies were carried out to isolate alkaloids from families such as Lauraceae, Annonaceae, Rubiaceae and Apocynaceae since alkaloids were generally known to be biologically active and many natural drugs are alkaloids (Jantan, 2004; Chan et al., 1966; Chan, 1968). Antioxidants play a vital role in neutralizing free radicals, thereby reducing oxidative stress and the risk of chronic diseases. Many Malaysian medicinal plants are recognized for their high antioxidant activity (Wan Yahaya et al. 2019). For example, *Orthosiphon stamineus* (*Misai kucing*) is known for its flavonoid content, which contributes to its antioxidant properties (Ashraf et al. 2018). Consuming these plants can provide health benefits and promote overall well-being by combating oxidative damage.

The antimicrobial properties of phytochemicals are another area of interest in Malaysian medicinal plants. Research has demonstrated that essential oils and extracts from plants like *Melaleuca alternifolia* (*Kayu putih*) possess significant antibacterial and antifungal activities (Carson & Riley, 1995). These properties make them potential candidates for developing natural antimicrobial agents, particularly in the face of growing

antibiotic resistance. Certain phytochemicals have shown promise in cancer prevention and treatment. For instance, studies have indicated that compounds like resveratrol found in Malaysian plants exhibit anti-cancer effects by inhibiting tumour growth and inducing apoptosis in cancer cells (Wan Ghazali et al., 2015). The investigation of these compounds offer hope for developing novel cancer therapies derived from natural sources.

2.5 The Bidayuh Community in Sarawak

2.5.1 Background

Bidayuh is the collective name for several indigenous groups found in southern Sarawak, Malaysia, and northern West Kalimantan, Indonesia, on the island of Borneo which are broadly similar in language and culture. The name Bidayuh means ‘inhabitants of the land. These communities constitute one of the main indigenous groups in Sarawak and West Kalimantan and live in towns and villages around Kuching and Samarahan, both in Sarawak. Most of the Bidayuh population is found within 40 km of the geographical area. They are the second-largest Dayak ethnic group in Sarawak after the Iban (Wikipedia, 2022 onwards). The Bidayuh community in Sarawak has been divided into five major groups (Figure 2.2) according to their dialect and location (Noeb & Ridu, 2012). The three largest groups according to locations or districts are Bau, Padawan (Kuching district), and Serian, while the smallest group is Selako-Rara from Lundu district.

2.5.2 Traditional Medicine of the Bidayuh Community

The Bidayuh community, like other ethnicities, uses traditional medicines as both preliminary and final treatments for any disease. Baling et al. (2017) demonstrate that the

Bidayuh Community in Bau District still relies on medicinal plants to treat a variety of diseases. Ripen and Noweg (2017) also highlight the documentation on medicinal plants from Mount Jagoi. Meekiong et al. (2021) identified over a hundred ethno-plants used by the Bidayuh community in Bau's Bungo Range National Park, including those used for medicinal purposes. Khamisiyah (2006) reported on the Selako-Bidayuh medicinal plants of Sematan, Lundu. While Sait et al. (2018) reported on the indigenous knowledge and theuses of natural resources by the Bidayuh people in Padawan, and Campbell and Mikeng (2019) discussed on the plants related to spiritual. Aside from that, there are no other scientific works or publications on the Bidayuh community in the Serian division.

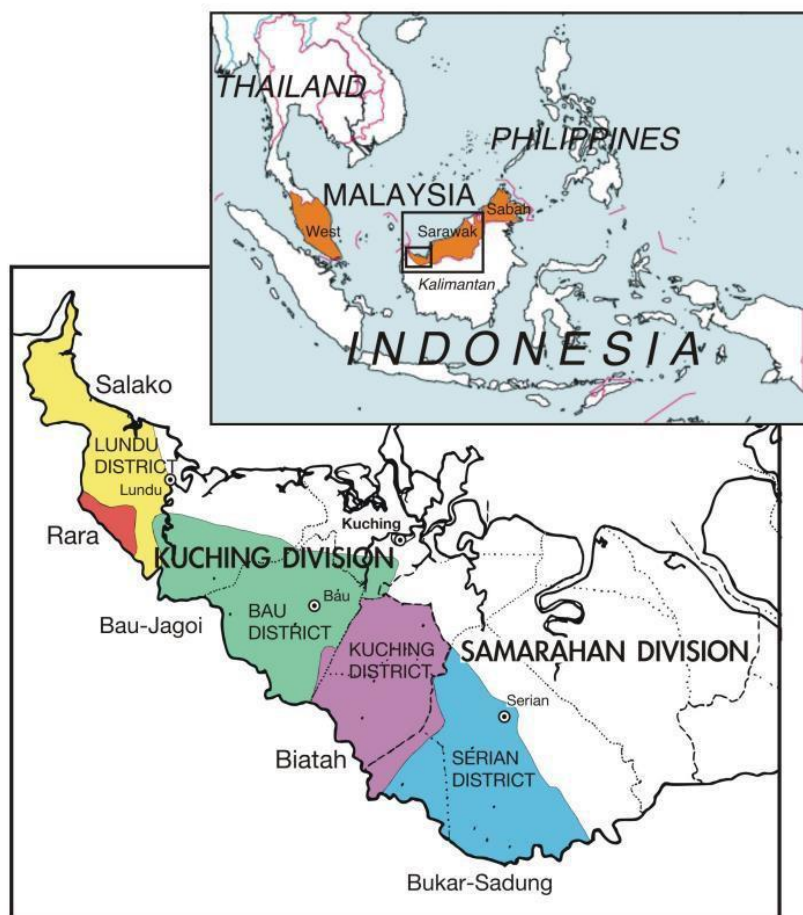


Figure 2.1: Map of the Bidayuh community in Sarawak based on their language and location (source: Noeb & Ridu, 2012)

CHAPTER 3

MATERIALS AND METHODS

3.1 Study Sites

The study was conducted in Sarawak, specifically in the Serian Division (Figure 3.1). Serian Division is the 12th managerial division in Sarawak that was recently gazetted (separated from Samarahan Division on 11 April 2015). Located about 64 KM from Kuching City, this Serian is the smallest division with a coverage area of 2,039 KM². The population is about 90,763 (the year 2010 census) with about 65% of the community being the Bidayuh people, and the remaining are Iban, Chinese, Malay and others.



Figure 3.1: Serian Division, Sarawak

There are a total of 144 villages with about 14,540 houses have been registered for the Serian Division. Administrative managerial is divided into five zones, based on politician Assemblymen. The five zones are Muara Tuang (shared with Samarahan Division), Siburan, Tarat, Kedup and Tebedu. Four villages have been selected randomly from each zone based on the criterion of distance from the Serian two (e.g., two nearest to town and two furthest). Siburan was omitted due to no Bidayuh's village in this zone. The location of the selected villages is shown in Figure 3.2 below.

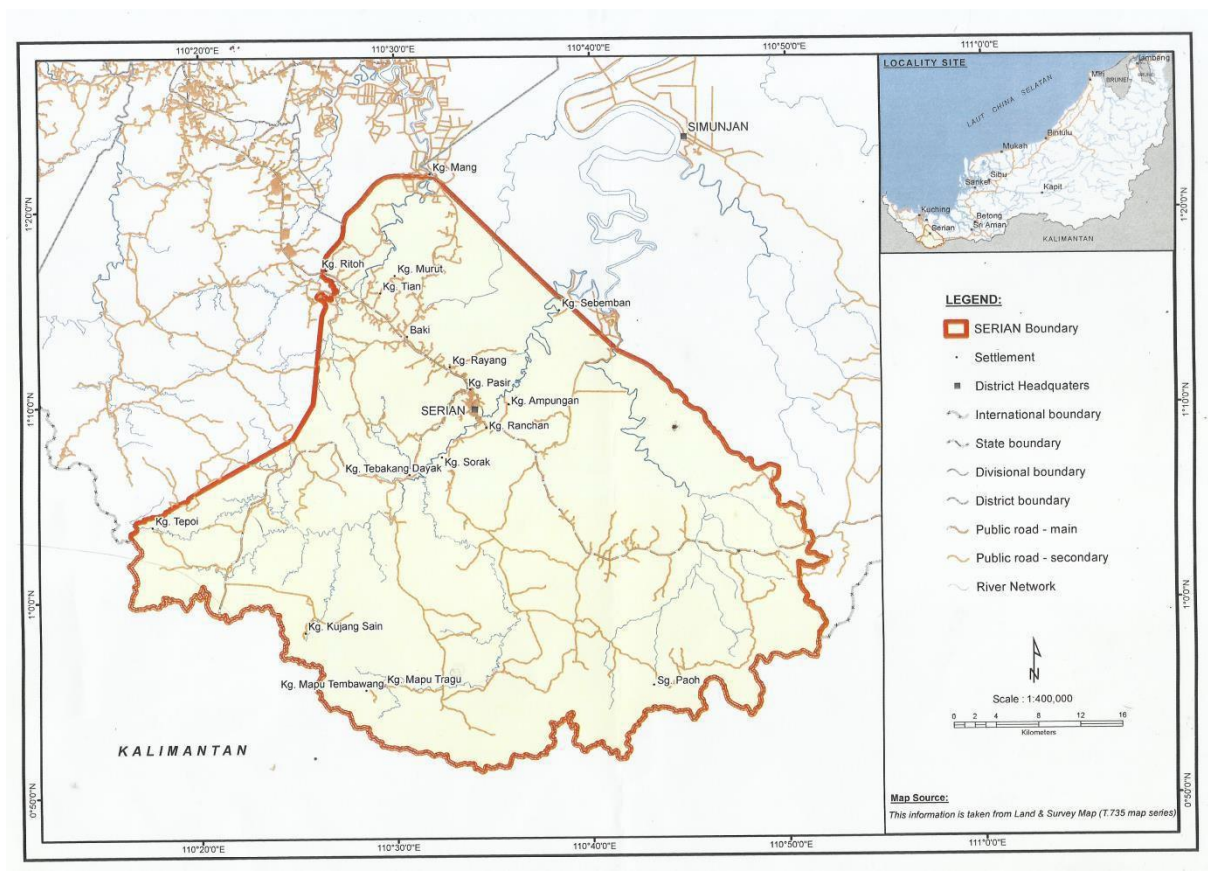


Figure 3.2: Study sites in Serian Division, Sarawak

3.2 Materials

3.2.1 Data Collection

Preparation

The field data collection was conducted based on key principles questions as stated in Chapter 1.4 (above) as supported by Young (2007), and, Sydara et al. (2014). Thus, to obtain related data, field data collection was conducted by adopted methods as suggested by Martin (1995). A preliminary survey has been carried out by approaching the headman (*Ketua Kampung*) of the village to find a knowledgeable person on medicinal plants and to seek approval to survey the village. After being granted by the headman, a series of interviews with potential respondents were conducted.

Interview

A series of interviews were conducted in the selected villages during 36 months of the project. All ethnobotanical information was gathered by Snowball random method by interviewing respondents using some semi-structural questionnaires (modification from Ong et al. 2010) (Appendix 1). Respondent is referring to the selected persons that were identified by the *Ketua Kampung*, such as shaman (Bomoh), ketua gawai (Pagan), individual practitioners and women. The interview process has been carried out both at their home and in the field. The survey form or interview was conducted in a local dialect (Bidayuh Serian – preferable as most of the respondents are old and more convenient in their local language).

All information was recorded in the notebook. A list of respondents from the selected villages who were involved in this project is listed in Appendix 2

3.2.2 Plant Specimens collection, identification and preservation

Specimen collection

Only good-quality samples were collected for herbarium specimens in form, either as a whole (herbaceous plants) or in portions (shrubs or trees) (Zakaria & Mustafa, 2015). A quality herbarium specimen should be a fertile sample (bearing either flowers or fruits or both). All the relevant parameters such as habitat, size, colour etc were recorded in the field notebook (Appendix 5) in the field. Photographs of every specimen are important to help in its identification and for the record. The collected materials were put in heavy-duty polythene bags preserved with 70% alcohol and brought back to the laboratory to be processed for herbarium specimen.

Alongside the physical collection, meticulous field notes are indispensable. Documentation of vital characteristics of the plant, including its growth habit, colour, size, and any distinctive features was jotted down. Additionally, the location of the collection, the date, and the specific habitat conditions provide essential context for future reference. This information not only helps in identifying the specimen but also contributes to ecological data that can be valuable for research.

Plant Identification

Plant identification is a crucial stage to make sure the plant collected is the correct species. The specimens were identified to the lowest rank possible (to species level). The identification processes were conducted in herbaria, viz. Herbarium UNIMAS

and SAR, and cross-checking with descriptions and images from monographs, books and references (e.g., Chai, 2006; Hussain et al.; 2015; Zakaria & Mustafa, 2015; WHO 1999, 2006, 2007, 2009, 2010). Also, referred to plant experts from the Sarawak Biodiversity Centre (SBC), UNIMAS and Sarawak Forest Department (SFD).

Herbarium specimens' preparation

Herbarium specimens serve as vital resources for botanical research, education, and conservation. They provide a permanent record of plant species, aiding in the study of biodiversity, ecological relationships, and plant taxonomy. The preparation of these specimens involves a systematic approach that ensures the plants are preserved in a way that maintains their essential characteristics for future study. The detailed process of collecting, pressing, mounting, labelling, and preserving herbarium specimens, specifically focusing on trees, shrubs, and herbs follows as suggested by Bridson and Foreman (1992).

Pressing the Specimens

Once the specimens were collected, the next step was to press them to facilitate drying. The pressing method involves placing the plant material between sheets of newspaper or blotting paper. To apply pressure, a plant press or heavy books were used. It is crucial to ensure that the specimens are spread out adequately to prevent overlapping, which could hinder the drying process. Drying is a critical aspect of specimen preparation. The pressed specimens were left for several days to a week (depending on plant types) in the drying oven, with regular changes of the paper to absorb moisture effectively. The goal is to dry the specimens thoroughly, as any remaining moisture could lead to mould growth and degradation of the plant material later on.

Mounting the Specimens

After the specimens have dried adequately, they are ready for mounting. This process involves affixing the specimens onto a standard herbarium sheet, typically measuring 30.5 cm x 46 cm. It is important to use a suitable adhesive, such as gum or another environmentally safe glue, which may contain fungicides to prevent decay. The specimen was mounted and arranged in a neat and organized manner, ensuring that all parts were visible for identification purposes. The label, which contains essential information about the specimen, then was glued and placed in the lower right corner of the herbarium sheet. This organization not only aids in identification but also enhances the overall presentation of the herbarium collection.

Labelling

Labelling is a crucial part of herbarium preparation. Each specimen must have a label that includes pertinent information: the scientific name (genus and species), common name (if applicable), collector's name, collection date, location (including latitude and longitude if possible), and a description of the habitat where the plant was found. Accurate labelling ensures that the data associated with the specimen can be easily understood and utilized by future researchers and educators.

Preservation

To ensure the longevity of herbarium specimens, proper preservation methods were employed. One effective strategy is treating the specimens with a fungicide solution, such as a 2% solution of zinc sulfate (the use of mercuric chloride was banned due to its hazardous), which helps to prevent mould and decay. The mounted specimens then were placed in the herbarium cabinet, according to their family placement.

Special Considerations for Different Types of Plants

When preparing herbarium specimens, it is essential to consider the specific requirements of different types of plants. For instance, herbs are typically pressed and dried in the same manner as other plants, with an emphasis on including flowers and fruits when available. In the case of shrubs and trees, collectors may need to focus on smaller branches or leaves instead of entire plants to ensure representative samples. For succulent plants, pressing is not advisable; instead, they can be preserved in a solution of 4% formalin or FAA (Formalin Acetic Alcohol) to maintain their structure.

3.3 Compiling Previous Related Data

The compiling of the previous related data was conducted in various libraries (UNIMAS PeTARY, State Library etc.) – books, journals and monographs as well through the internets. The data was also sought via plant specimens deposited in the Herbarium of Forest Department Sarawak (SAR), Herbarium of UNIMAS and SBC.

3.4 HPLC Analysis

3.4.1 Collection and Extraction of Plant

Standard, Chemicals and Materials

The HPLC analysis for this study was limited to five compounds: Carvacrol, Emodin, Phenol, Quinine, and Thymol. This is due to time constraints and the standards' obtainability. The studies were carried out during the Malaysian Movement Control Order (MCO) period when purchasing and shipping of standards and other substances (especially from outside Malaysia) were severely limited. Because those are the only five standards available in the local market or in local inventories and purchased before the Covid-19 crisis, they were chosen and used for this HPLC analysis. Additionally, the five compounds that were selected for this study all were related to skin diseases (that contains anti-bacterial, anti-fungus and anti-virus elements).

The Standard of Carvacrol was bought from ChromaDex. Inc. (Fordham St Suite, Longmont), Standard of Phenol, Standard of Quinine and Standard of Thymol were obtained from LGC Limited (Middlesex, UK), and Standard of Emodin was purchased from Toronto Research Chemicals (Toronto, Canada) (Figure 3.3 – Figure 3.7). The solvents used are Dichloromethane and Ethyl acetone. Other materials include, HPLC grade acetonitrile, water (Milli-Q), acetic acid (HPLC grade), Whatman no. 1 (filter paper), and doubly-distilled deionized water, used throughout the study, Maxi-clean RP solid-phase extraction (SPE) C18 cartridges and 0.45 μm filters. All laboratory works were conducted in UNIMAS Laboratories.

Preparation of Standard Solutions

Standard stock solutions of compounds 1-5 were prepared in solvent Hexane, Dichloromethane and Ethyl acetone respectively at a concentration of 0.5 mg/mL, Standard mixture solutions were prepared at various concentration levels in the range of 5 - 250 ppm. All solutions were filtered before analysis through a 0.45 μm syringe filter and injected four times into the HPLC. The calibration curve for each compound was constructed by plotting the peak area as a function of the standard analyte concentration.

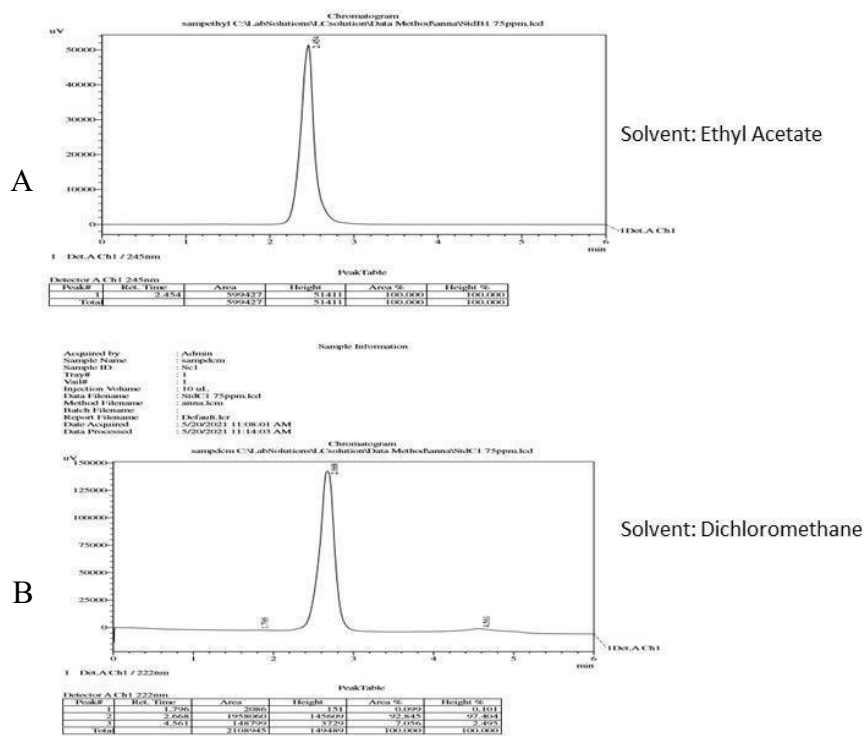


Figure 3.3: Reference Standard Carvacrol for solvents (A) Ethyl Acetate and (B) Dichloromethane

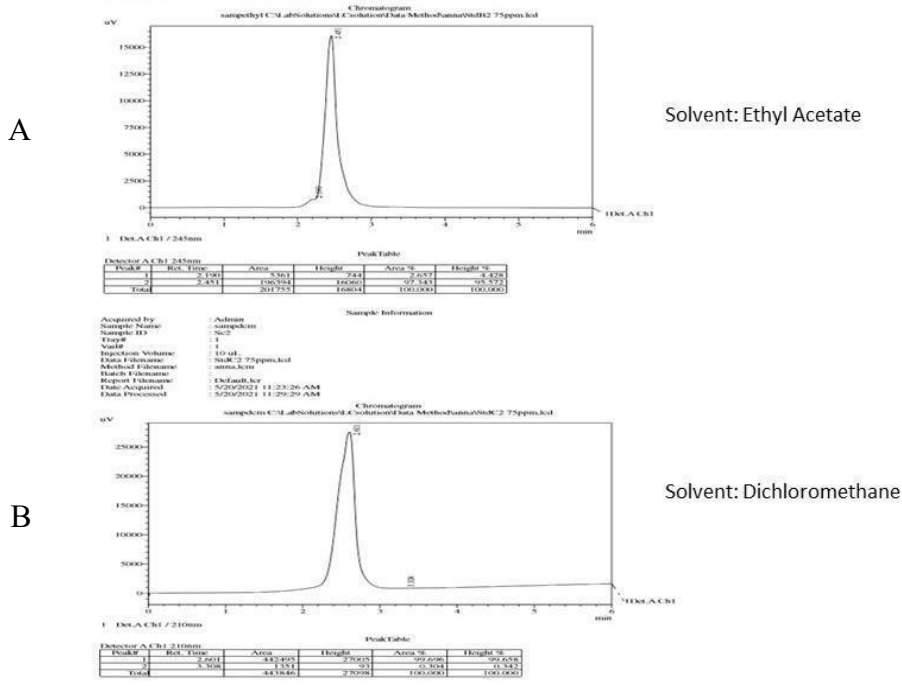


Figure 3.4: Reference Standard Phenol for solvents (A) Ethyl Acetate and (B) Dichloromethane

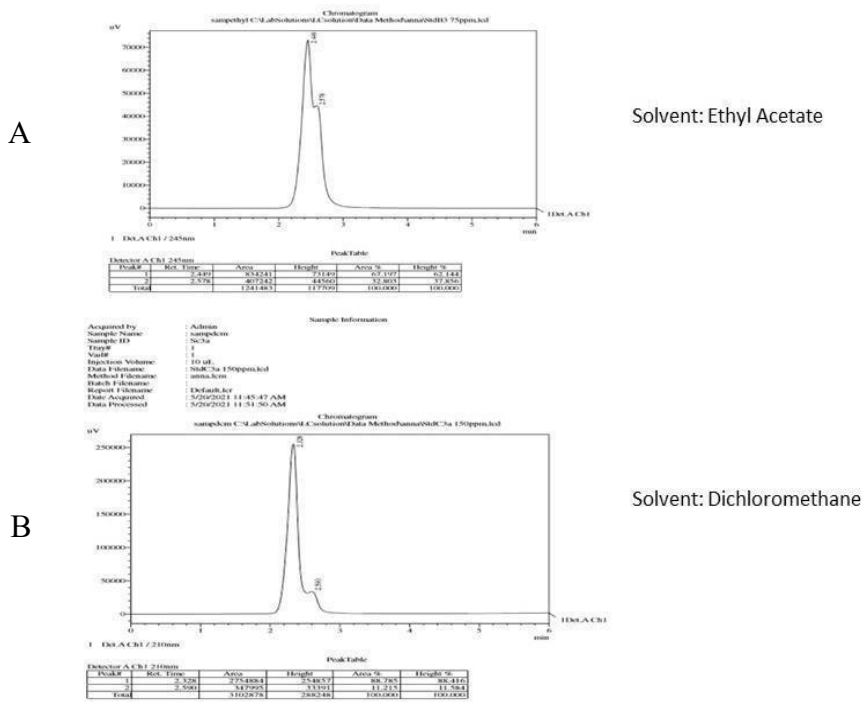


Figure 3.5: Reference Standard Quinine for solvents (A) Ethyl Acetate and (B) Dichloromethane

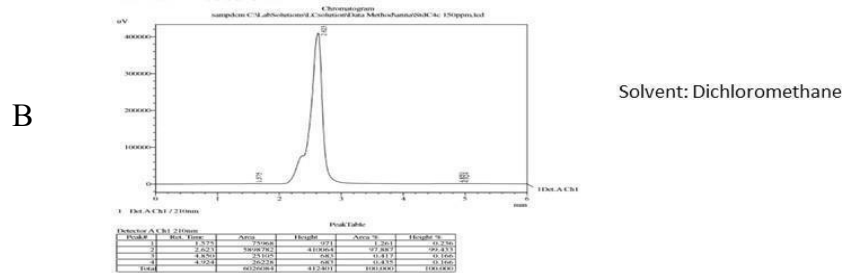
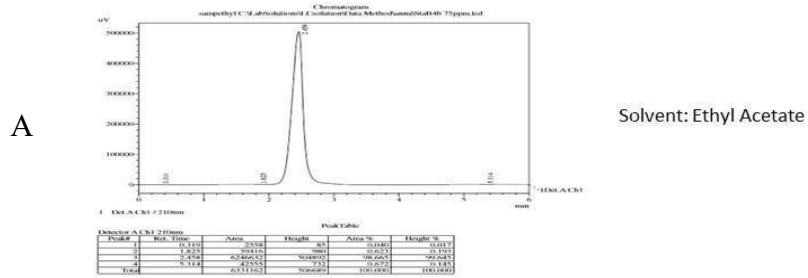


Figure 3.6: Reference Standard Thymol for solvents (A) Ethyl Acetate and (B) Dichloromethane

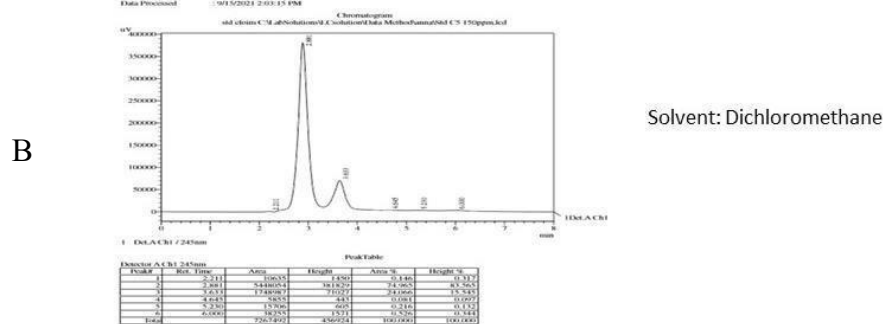
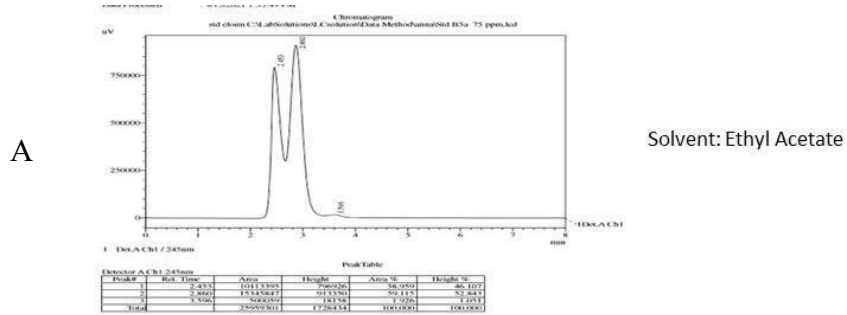


Figure 3.7: Reference Standard Emodin for solvents (A) Ethyl Acetate and (B) Dichloromethane

Sample Preparation

All 19 selected plant materials (20 samples) were collected from the study sites washed, dried under shade and pulverized by using a mechanical grinder to make a coarse powder. Then 850 g powder was soaked in three different solvents accordingly, (Sample B: ethyl acetate, and Sample C: dichloromethane) at ambient temperature (25–28 °C) for successive extraction. The whole extract was collected and filtered and the solvent was evaporated to dryness under reduced pressure and temperature respectively by using a rotary evaporator.

The extraction procedure was repeated two times, after which the two extracts were combined and filtered using Whatman no. 1 filter paper. The extraction solvent was removed by the use of rotary evaporation. The dried extract was stored at 4 °C for further use. Solid-phase extraction (SPE) was used to remove unwanted interfering phytochemicals from the root extract. The SPE procedure was performed on an Alltech extraction manifold system. SPE C18 cartridges (4 mL; 600 mg) were first conditioned with 4 mL methanol, followed by 4 mL water. Following the conditioning step, 4 mL of the diluted root extract was loaded onto the cartridge. After sample loading, the interfering compounds were removed with 2 mL of 10% aqueous ethanol.

Finally, the fraction containing compounds 1-6 was eluted with 2 mL of hot ethanol (60 °C). The vacuum pressure was kept at 10 mm Hg during the pre-conditioning step and was held constant at 2 mm Hg during the loading and eluting steps. Four replicate SPE extracts were collected. Each eluate was diluted to 5 mL with ethanol. The diluted SPE root extract, the eluate, was then filtered through a 0.45 µm syringe filter and injected into the HPLC. Each diluted SPE extract was injected into the HPLC five times, and the average peak area was reported and used for analyte quantification.

3.4.2 Analysis

Separation and quantitative analyses of compounds 1-5 were performed on a Shimadzu HPLC system (Kyoto, Japan) consisting of an SCL-10A system controller, two LC-10AD pumps, DGU-14A degasser, SIL-10AD auto-injector and an SPD-10AV UV-VIS detector ($\lambda = 260$ nm). Separation of the analytes was performed at 50 °C on a Phenomenex Luna C18 (2) column, 100 Å pore size, 5 µm particle size, 250 × 4.6 mm ID column containing a guard column (Phenomenex, Torrance, CA, USA). The analyses were eluted isocratically at a flow rate of 1 mL/min using an acetonitrile/water/acetic acid (60: 39.5: 0.05, v/v), The injection volume was 20 µL.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 The Serian Bukar-Sadong Community

4.1.1 Respondents

Preliminary and Intensive Surveys

A preliminary survey was conducted in sixteen selected villages (four each from four zones) to identify the traditional medicine practitioners. A total of 870 respondents (aged above 18 years old) were selected randomly from the selected villages (Figure 1, Table 4.1). Of the total of 870 respondents, 268 respondents were willing to share their medical wisdom, while the remaining respondents either did not have any knowledge of traditional medicine or were not willing to share their knowledge (Table 4.2).

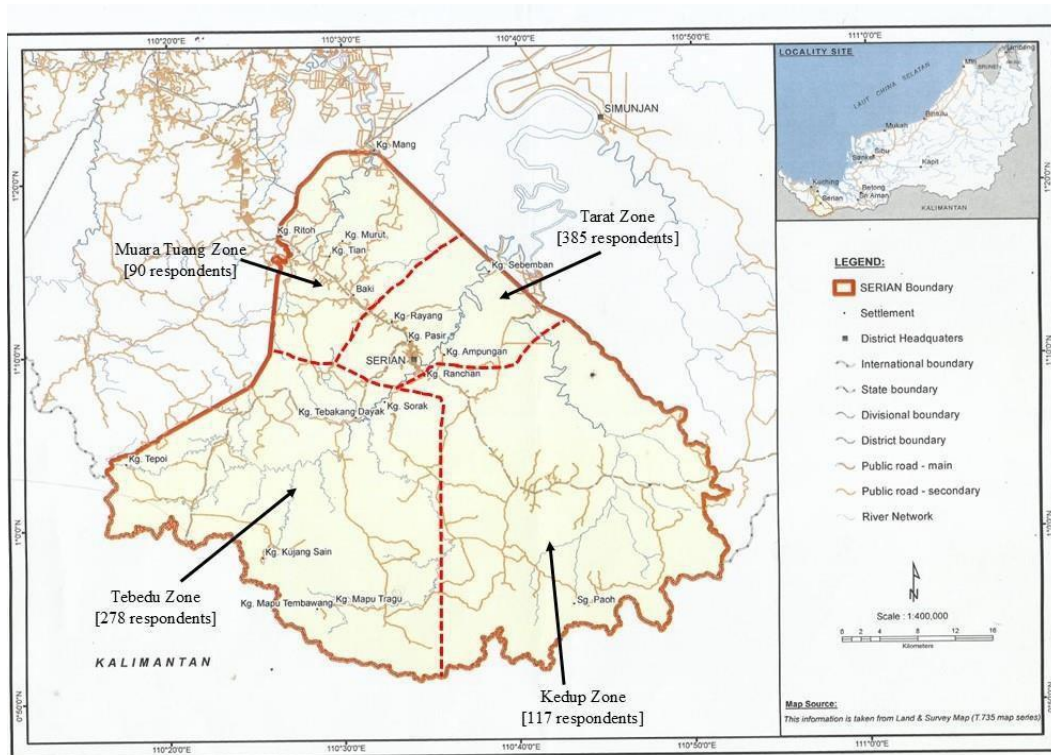


Figure 4.1: Number of respondents (10% of the populations) based on zonation

Table 4.1: Sixteen selected villages surveyed (total population and number of respondents)

Zone	Village	Total Population > 18 years	No of Respondents (10%)
Muara Tuang	Kpg Murud Mawang	129	13
	Kpg Mang Besi	82	8
	Kpg Plaman Baki	335	33
	Kpg Tian Mawang	361	36
Tarat	Kpg Rayang	1438	144
	Kpg Ampungan	1457	146
	Kpg Sebemban	435	43
	Kpg Rituh Labuan	521	52
Kedup	Kpg Sg Paon	86	9
	Kpg Mapu Kijabu	566	57
	Kpg Pasir Stabun	253	25
	Kpg Ranchan	261	26
Tebedu	Kpg Tepoi	510	51
	Kpg Sorak Sampung	873	87
	Kpg Kujang Sain	403	40
	Kpg Tebakang Dayak	1004	100
Total		8714	870

Table 4.2: Number of respondents (knowledge and willingness to share)

Zone	Village	No. of Respondents (10%)	Zero-knowledge	Not willing to share	Willing to share
Muara Tuang	Kpg Murud Mawang	13	3	3	7
			[23.1%]	[23.1%]	[53.8%]
	Kpg Mang Besi	8	4	2	2
			[50%]	[25%]	[25%]
Kpg Plaman Baki	33	16	4	13	
			[48.5%]	[12.1%]	[39.4%]
	Kpg Tian Mawang	36	15	3	18
			[41.7%]	[8.3%]	[50%]
Tarat	Kpg Rayang	144	95	18	31
			[66%]	[12.5%]	[21.5%]
	Kpg Ampungan	146	101	15	30
			[69.2%]	[10.3%]	[20.5%]
	Kpg Sebemban	43	22	6	15
[51.1%]			[14%]	[34.9%]	
Kpg Rituh Labuan	52	30	8	14	
		[57.7%]	[15.4%]	[25%]	
Kedup	Kpg Sg Paon	9	3	2	4
			[33.3%]	[22.2%]	[44.4%]
	Kpg Mapu Kijabu	57	30	5	22
			[52.6%]	[8.8%]	[38.6%]
	Kpg Pasir Stabun	25	8	5	12
[32%]			[20%]	[48%]	
Kpg Ranchan	26	15	5	6	
		[57.7%]	[19.2%]	[23.1%]	
Tebedu	Kpg Tepoi	51	25	10	16
			[49%]	[19.6%]	[31.4%]
	Kpg Sorak Sampung	87	45	15	27
			[51.7%]	[17.2%]	[31%]
	Kpg Kujang Sain	40	15	10	15
[37.5%]			[25%]	[37.5%]	
Kpg Tebakang Dayak	100	55	8	37	
		[55%]	[8%]	[37%]	
Total		870	483	119	268

Figure 4.2 shows a summary of knowledge and willingness among the respondents in the four zones of the Bidayuh Bukar-Sadong communities in the Serian Division. The surveys recorded that zero knowledge of the medicinal plants among the respondents for every zone more than 42 percent on average, with Tarat Zone was the higher, 64.4%, followed by Tebedu (50.4%), Kedup (47.9%) and Muara Tuang was the lowest with 42.2 per cent. According to Abdul Rahman et al. (2019), urbanization and culture modernization are among the factors that led to the loss of indigenous knowledge among the communities in Peninsular Malaysia, and this is significantly true with the case of Bidayuh Bukar-Sadong communities in the Serian Division. Deforestation of forest areas turning the forest into an urban city, and the preferable of young generations toward modernization (many of youngsters moving to Kuching and Samarahan) are among the factors documented.

A total of 119 out of 870 respondents (13.7%), recorded “not willing to share” their traditional medicinal plants knowledge. Among their reasons why they were unwilling to share their knowledge were including; (i) they only knew the plants via hearsay but not a practitioner, (ii) worriedness about sharing wrong information, and (iii) only knew the use of the plants but do not have knowledge on identifying plants.

A total of 268 respondents (30.8%) were willing to shared their wisdom, with Muara Tuang Zone was the highest (44.4%), followed by Kedup (37.6%), Tarat (23.3%) and the lowest was Tebedu with only 5 per cent. A script of interview one of the sharman representative as shown in Appendix 3. The distances of the villages from the nearest town (Serian), in the case of the Tebedu Zone, however did not show a significance result. According to Rahayu et al. (2020), the used of herbal medicine among the communities in Indonesia is significantly associated with area of residence (including distance), age, education level and occupation. Unwillingness to share and secretive among the respondents were probably factors that influenced the tendency of the lower result.

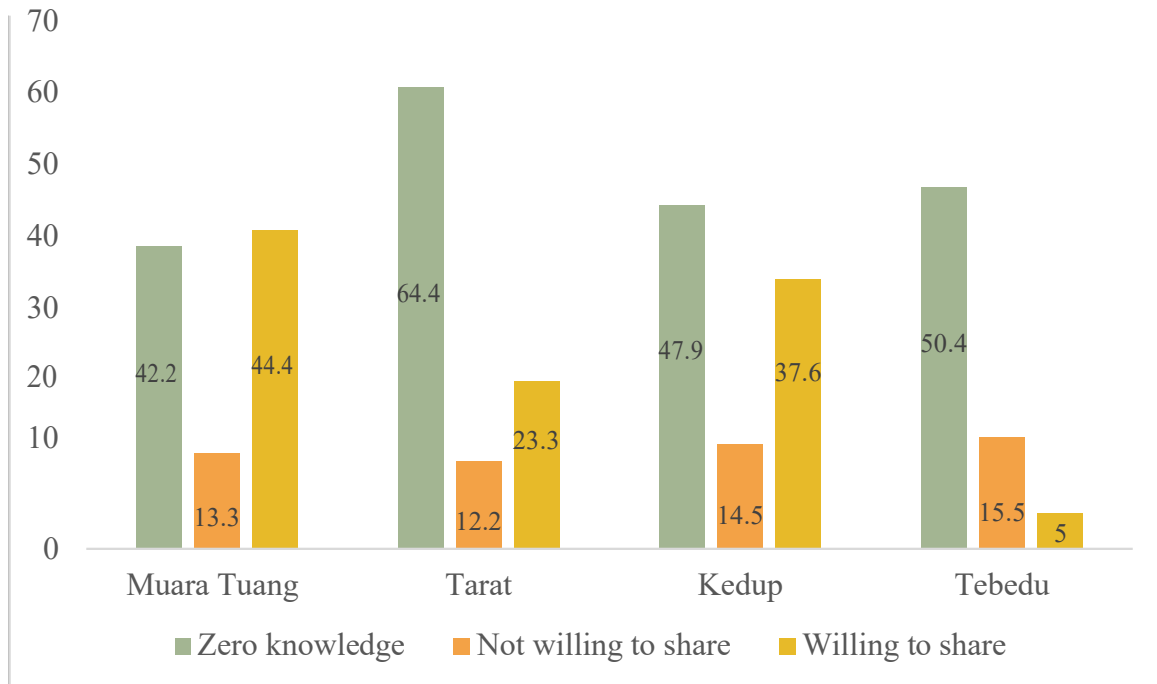


Figure 4.2: Summary of knowledge and willingness for zonation (in percentage)

Demography of Respondents

The demography of respondents or the traditional medicine practitioners from sixteen selected villages is as follows:

i. Gender

The number of respondents based on gender showed that 154 females (57.5 %) and 114 males (42.5%) are practitioners of traditional medicine in the survey area. In gender-based relative studies of the knowledge of medicinal plants, the social roles of women are classified as wives and daughters who are in charge of health, identifying illnesses, and knowing their diagnosis; habitually they are accountable for applying the first treatments (Menendez, 2003; Doyal, 2005). The result of this study is agreeable to Da Costa et al. (2021), which showed that women were better knowledgeable about practising and applying medicinal plants in daily life. By contrast, men are in charge of upholding the household economy and

providing resources, which make them know more about natural resources for other purposes, such as construction (Camou-Guerrero, et al., 2008; Caniago & Siebert, 1998; Reyes-Garcia, et al., 2010). Again, the result of this study settled with Da Costa et al. (2021), that men had better knowledge of the identification of medicinal plants in the natural habitats/forests.

ii. Age

The majority of the respondents interviewed were above 50 years old (176 persons = 65.7%) and 92 respondents were 50 years old and below (34.3%). Details of age groups as shown in Figure 4.3 below. According to Wayland and Walker (2014), the study demonstrated a relationship between a woman’s age and medicinal plant use but not between age and plant knowledge. The result of this study displays a similar pattern, in which most older women know about medicinal plant use but do not the knowledge of the plant itself (such as habitat, phenology etc.).

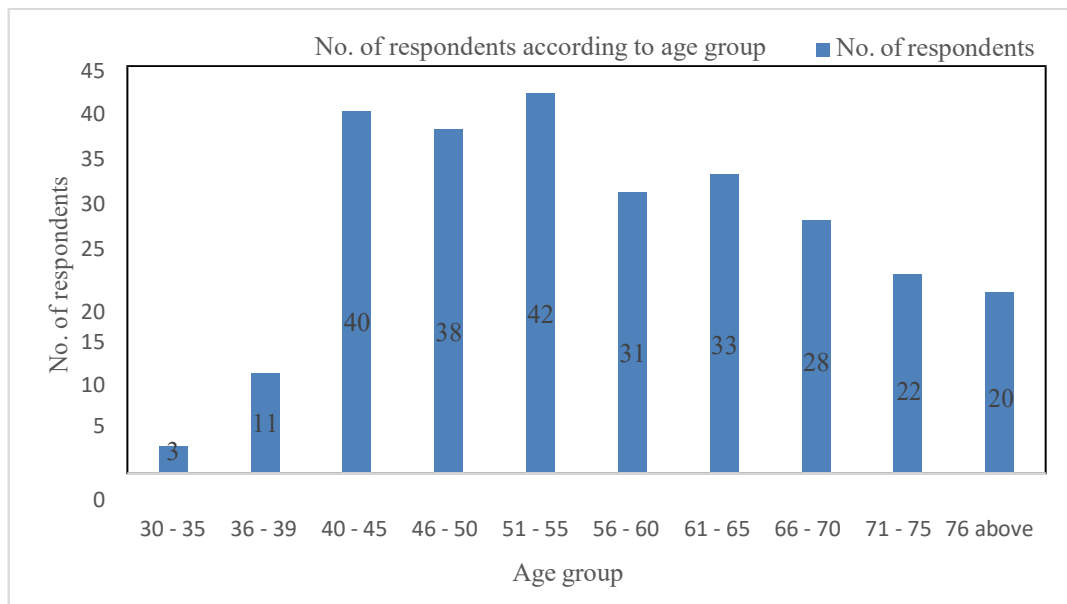


Figure 4.3: The number of respondents according to age groups

Research indicates that older adults tend to have a more extensive knowledge of medicinal plants compared to younger individuals. This is partly due to their longer exposure to traditional practices and the natural environment. For example, studies have shown that older community members often possess detailed knowledge about the medicinal properties of plants, including their uses and preparation methods (Wanjohi et al., 2020). In contrast, younger generations may have limited knowledge, often relying on modern healthcare solutions instead.

Traditional knowledge of medicinal plants is often deeply rooted in the experiences of older generations. Elders in many cultures serve as custodians of this knowledge, having accumulated insights over decades of interaction with their environment. For instance, older individuals may have first-hand experience with the efficacy of various plants, learned through trial and error or teachings from their predecessors (Mohiuddin, 2019). This experiential knowledge is invaluable, as it encompasses not only the identification of plants but also their preparation and application in healing practices.

The process of intergenerational learning is crucial for the transmission of traditional medicinal knowledge. Younger generations often learn from their elders through direct mentorship, storytelling, and practical demonstrations. This learning is typically place-based, meaning it is closely tied to the local environment and the specific plants that grow there (Ouma, 2022). However, this transmission is increasingly challenged by factors such as urban migration and the globalization of knowledge, which can disrupt these traditional learning pathways. In the case of Bidayuh Bukar-Sadong communities in Serian, according to the older, many of the younger generations are prefer to move to Kuching or Samarahan cities to get better occupations.

Modernization has a profound impact on the retention of traditional knowledge. As younger individuals migrate to urban areas for education and employment, they may become disconnected from their cultural roots and the traditional practices associated with medicinal plants (Ouma, 2022). This shift can lead to a decline in the knowledge base, as fewer young people engage with the practices that their elders once upheld. The reliance on modern medicine can further diminish the perceived value of traditional knowledge, creating a generational gap in understanding and usage.

Looking ahead, it is essential to explore innovative ways to bridge the gap between generations. Community-based initiatives that promote the sharing of knowledge between elders and youth can be effective in revitalizing interest in traditional medicinal practices. Workshops, community gardens, and cultural festivals can serve as platforms for knowledge exchange, ensuring that the wisdom of older generations is not lost (Ouma, 2022).

The results showed that the use of medicinal herbs among the Bidayuh Bukar-Sadong communities in Serian with age is highly significant (Figure 4.3). This is supported by a similar study by Oyeboode et al. (2016) in which they recorded the ages strongly correlated with the use of medicinal herbs. For example, about 89.8% (from 11,284 respondents) in China, and, 90.9% (from 3411 respondents) in South Africa are from the age 50 years and above. This means that correspondents' knowledge of medicinal plants correlates with their ages. This is consistent with many studies on traditional knowledge around the world, where skills and knowledge are largely passed down from generation to generation.

The relationship between the use of medicinal herbs and gender was also investigated. However, there is no significant between the use of medicinal herbs and gender. It means that the Bidayuh Bukar-Sadong population in the Serian division's use of medicinal plants is unaffected by gender. The result, however, diverges from a study by Oyeboode et al. (2016), in which they reported about 50 – 66% of the traditional medicine practitioners from middle-income countries are from the female group.

iii. Educational Level

The relationship between educational level and traditional knowledge practices is an important topic that highlights the dynamics of cultural preservation and adaptation in modern society (Seerangan & Ravi, 2023). As educational systems and access to formal education evolve, how traditional knowledge is valued and practised also changes (Chaika, 2023). Understanding this connection can shed light on how societies navigate the balance between maintaining cultural heritage and embracing modern advancements. Traditional knowledge practices encompass the skills, experiences, and understandings that have been passed down through generations within a community (Sousa et al., 2022; Az-Zahra et al., 2021). These practices often include agricultural methods, medicinal uses of plants, crafting techniques, and spiritual rituals. Traditionally, this knowledge is transmitted orally, with elders serving as the primary educators. However, the rise of formal education has introduced new paradigms in which knowledge is acquired and valued, often leading to shifts in how traditional practices are perceived (Berkes, 2008).

Most of the traditional medicine practitioners in the survey areas had with primary school background, 119 respondents (44.4%), and, without formal education (no education), 96 individuals (35.8%) of the total number of respondents (Figure 4.2). According to WHO (2000), the educational level somehow shows the least significance in traditional medicine applications. Traditional medicine practitioners have developed unique methods of diagnosis and treatment that are specific to their particular cultures. Some of these approaches based on complex theoretical frameworks which can be traced back as far as 3500 years. According to Law and Soon (2013), the uses of herbal medicines in Malaysia are agreed to by WHO (1999), which are based on practical experiences, observations, and rituals derived from socio-religious beliefs passed down from one generation to another.

The level of formal education can significantly influence the retention and application of traditional knowledge. Individuals with higher educational attainment may possess a different understanding of knowledge, often prioritizing scientific and empirical evidence over traditional practices (Vaughan.; 2018). As shown in Figure 4.4, there were only 12 persons (4.5%) from the higher educational practices traditional medicines for the Bidayuh Bukar-Sadong recorded. As a result, some traditional knowledge may be overlooked or undervalued in favour of modern techniques and technologies. This can lead to a diminishing interest in traditional practices among educated youth, as they may see them as outdated or irrelevant (Nakashima & Roue, 2002).

Although the use of medicinal plants has been decreasing gradually, a study conducted by Strgar et al., (2013) in their study of Slovenian students shows about 85% of the total 294 students knew or used medicinal plants. A study by Arumugam (2019) among Malaysian consumers showed a significant relationship between educational level and knowledge of medicinal plants at Chi-Square ($P = 0.033$). The result from this study is congenial to others, indicating that the level of education does not influence the number of people who use medicinal plants.

Education plays a pivotal role in shaping the knowledge landscape of medicinal plants (Mbelebele et al., 2024). Formal education systems often prioritize scientific knowledge over traditional practices, which can lead to a devaluation of the latter. However, integrating traditional knowledge into educational curricula could foster a greater appreciation among younger generations. This approach not only helps preserve traditional knowledge but also encourages a more holistic understanding of health and wellness.

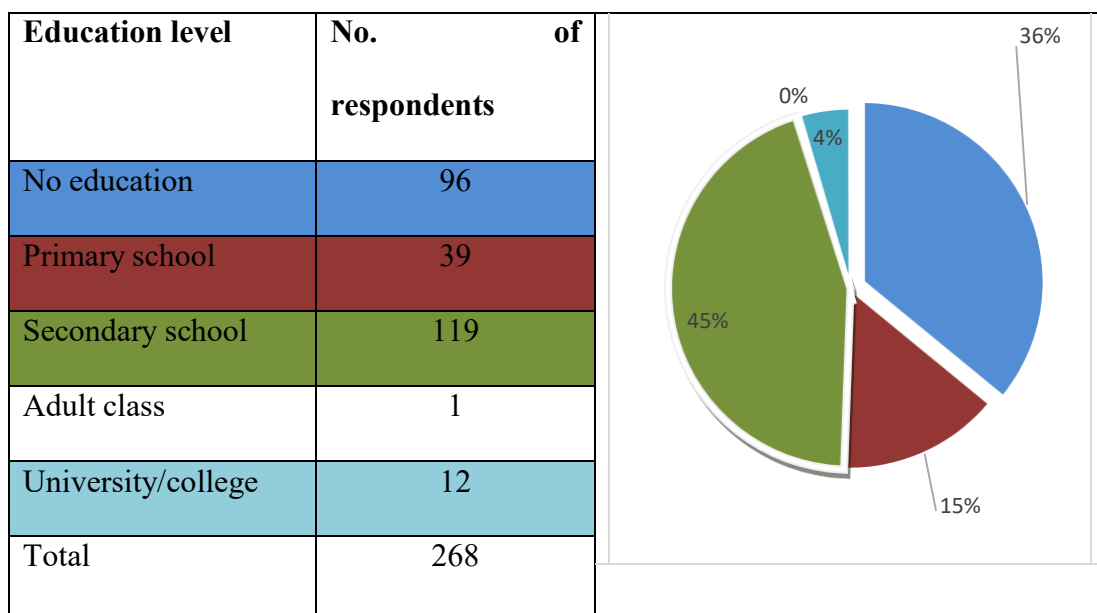


Figure 4.4: The educational level of respondents

To effectively bridge the gap between traditional and modern knowledge, there is a growing recognition of the need for integrative education. This approach combines traditional practices with contemporary scientific understanding, creating a more holistic educational experience. For example, agricultural courses that incorporate traditional farming techniques alongside modern practices can enhance students' appreciation for both. Such integration not only preserves traditional knowledge but also enriches the learning experience for students. (Sillitoe, 2002; Gadgil & Berkes, 2000).

iv. Occupation

The relationship between occupation and traditional medicine practices is shaped by a variety of factors, including sociodemographic characteristics, cultural beliefs, economic conditions, and educational backgrounds. Traditional medicine is defined as the total of knowledge, skills, and practices based on indigenous theories and beliefs, plays a crucial

role in maintaining health and treating illnesses across various cultures (Ndhlala et al., 2013). Understanding how occupation influences the use and preference for traditional medicine can provide insights into healthcare accessibility and cultural identity.

Of 268 respondents, the majority are farmers and housewives with 117 and 46 individuals respectively, and 15 respondents from government staff and retired government staff each (Figure 4.5). About 75 respondents were from various non-government staff sectors, such as labourers, clerks, mechanics or drivers in the companies. Based on the study by Law and Soon (2013), the relationship between occupation and herb use was not significant. About 23.3% of 460 women surveyed, with educational and occupations, also believe in the use and practising of medicinal herbs during their pregnancy. Their finding is courteous with another study by Azriani et al. (2008). Thus, the result of this study also figured out that occupation did not impact the use of medicinal herbs by the practitioners.

Cultural beliefs and practices are deeply intertwined with occupation (Febriyanti et al., 2024). Individuals engaged in occupations that are closely linked to their cultural heritage, such as farming or community leadership, may be more inclined to utilize traditional medicine. This is because traditional practices are often embedded in the cultural identity of these communities, serving not only as health interventions but also as a means of preserving cultural heritage. For example, in many indigenous communities, traditional healers play a vital role in health care, and their practices are respected and integrated into the community's daily life.

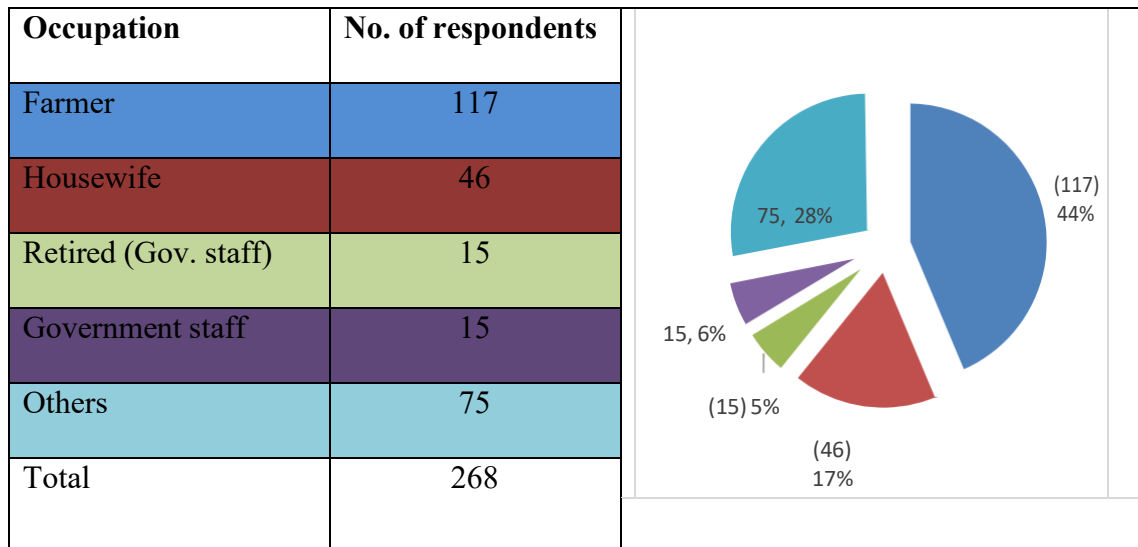


Figure 4.5: Occupation of the respondents

Educational attainment, which is frequently linked to occupational status, also plays a critical role in the acceptance and use of traditional medicine (Oreagba et al., 2011). Individuals with higher education levels may have a better understanding of modern medical practices and may be more sceptical of traditional remedies (Febriyanti et al., 2024). Conversely, those with lower educational backgrounds might have a stronger reliance on traditional medicine due to a lack of awareness or understanding of modern healthcare options (Wassie et al., 2015). This dynamic underscores the importance of education in shaping health beliefs and practices.

Economic status, often determined by occupation, significantly influences the choice of healthcare practices. In many regions, traditional medicine is seen as a cost-effective alternative to modern healthcare, which can be prohibitively expensive for those with lower incomes. This economic aspect is crucial, as it highlights the necessity for accessible healthcare options that align with the financial realities of different occupational groups (Fokunang et al., 2011). Moreover, traditional medicine often utilizes locally available resources, making it a practical choice for those in economically disadvantaged positions.

4.2 Medicinal Plants Documentation

4.2.1 Plant Collection

A total of 126 plant taxa were collected and recorded from eight selected villages that consist of 56 families, 104 genera and 126 species (Appendix 4). Family Zingiberaceae was the most specious with 10 species recorded, followed by Poaceae (8 spp.) and Arecaceae (6 spp.). Three families were recorded with five species (Asteraceae, Fabaceae and Rubiaceae) and seven with four species each namely, Annonaceae, Apocynaceae, Araceae Lauraceae, Phyllanthaceae, Piperaceae and Rutaceae. Six families with three species five others with two species and the rest (32 families) with only one species each were recorded. Thirteen most specious families are shown in Figure 4.6 below.

Compared with other areas that were occupied dominantly by the Bidayuh ethnic, such as Bau and Padawan areas, the number of plants recorded is moderately high. The Padawan (Bungo Range National Park) area alone recorded about 363 plant species (102 families, 258 genera) as reported by the FDS (2019). However, Martin (1997) and, Ripen and Noweg (2017) recorded a lower number of medicinal plant species from Bau (40 spp.) and Singai (52 spp.) respectively. According to Martin (1995), the number of specimens collected is correlative with the time or timeframes of the project. The longer a project is conducted the more data will be gathered (until it reaches the maximum number). The sizes of the project area and the number of populations however are the least important. For instance, the number of medicinal plants recorded from Gunung Lesong National Park (coverage area 550 ha, \approx 20 villages) is comparable to Bungo Range National Park (coverage area 8096 ha, \approx 40 villages) as reported by Forest Department Sarawak (2019).

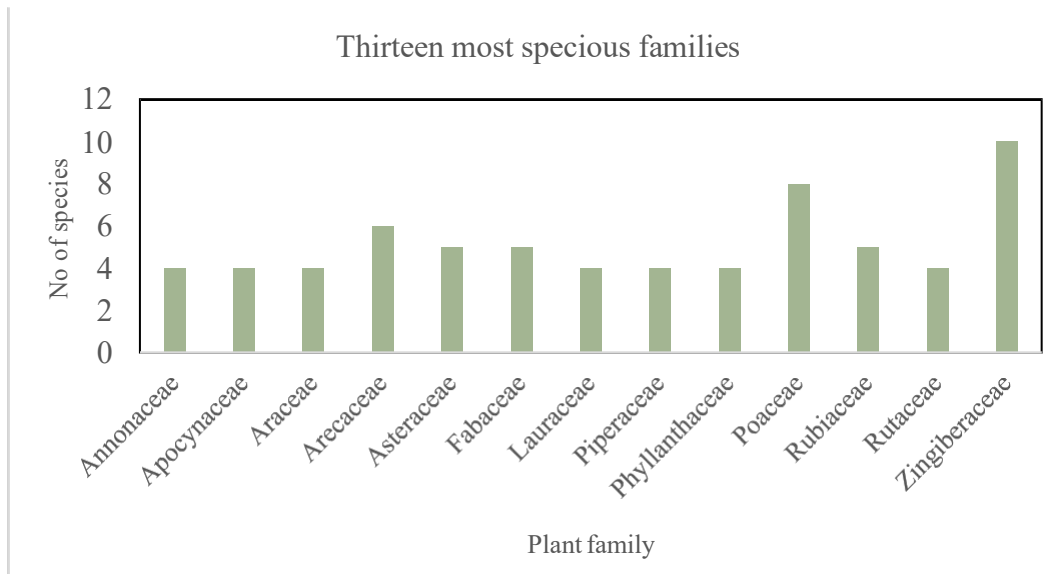


Figure 4.6: Thirteen most specious families were collected and recorded by the Bidayuh people in Serian Division

Among 126 plant species recorded, 24 were considered non-native plants. They were planted as a cash crop, ornamental or for medicinal purposes. For example, *Theobroma cacao* L. (*Pingkidup dihan/Koko*) was planted as a cash crop and *Aloe vera* (*Lidah buai*) as an ornamental plant. While *Phaleria macrocarpa* (Scheff.) Boerl. (*Mahkota dewa*) which is originally from Indonesia, and planted purposely for medicinal use. Other non-native plants are *Abelmoschus esculentus* (L.) Moench., *Alpinia purpurata* K. Schum., *Annona muricata* L., *Allium cepa* L., *Carica papaya*, *Ocimum basilicum*, *Zingiber spectabile* etc.

Plant Habit

Plant habit is categorized into six groups, viz. tree/treelet, shrub, herbaceous, climber, palm and ferns. Of 126 species recorded, about one-third were dominated by herbaceous plants, while a combination of tree/treelet and shrub also contributed one-third of the total number of plants collected and recorded (Figure 4.7).

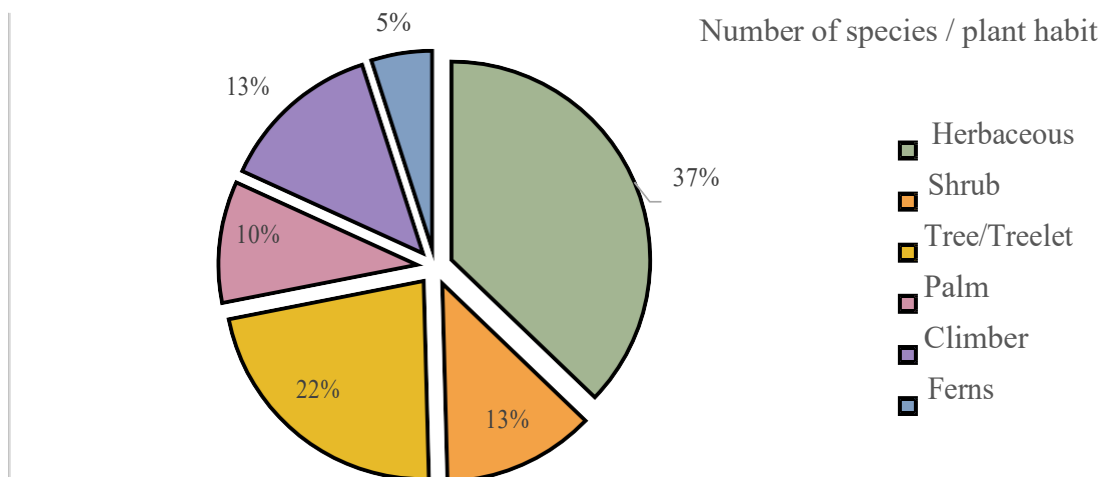


Figure 4.7: Plant habits were collected and recorded by the Bidayuh people in Serian Division

The result is agreeable with many ethnobotanical studies that have been conducted throughout the world, with most of the medicinal plants used by the indigenous peoples being herbaceous plants (e.g., Sharma, 2008; Jadid et al., 2020). For instance, Pandita et al. (2013) reported 105 herbaceous plants used by the community in District Samba of Jammu in India for various medicinal purposes. While in Malaysia, Burkill (1935) listed more than 1300 medicinal plants from Peninsular Malaysia alone, of which the majority are herbaceous plants. The simple reason given by the respondents is that herbaceous plants are more dominant than any other plant groups (abundant – can be found in a large quantity), easy to harvest (non-woody) and propagate. Furthermore, most herbaceous plants are terrestrial, with small or regular sizes that can easily be sighted.

Surprisingly, the number of fern species used for medicinal purposes was very low, only six species were collected and recorded. According to Nuruddin et al. (2006), many fern species have been used in traditional medicine as a remedy for illness and contraceptives. Mazhani et al. (2020) stated that about 132 and 50 fern species have been documented in India and Malaysia respectively, for medicinal purposes. In contrast, most of

the fern species collected by the Bidayuh people in survey areas are mainly for consumption (vegetables and *ulam*), for example, *Miding* (*Stenochlaena palustris*), and *Paku kubok* (*Nephrolepis biserrata*). Rajoo et al. (2023) and Forest Department Sarawak (2019), also reported a similar scenario from other ethnics in Sarawak, Kenyah and Iban correspondingly.

The Location of Medicinal Plant Sources

The availability of medicinal plants in proximity to local communities greatly influences their usage patterns (Krsnik & Erjavec. 2024). For many Sarawakians, particularly indigenous groups such as the Iban and Bidayuh, the reliance on these plants is deeply embedded in cultural practices. The following aspects highlight the influence of location on the daily use of medicinal plants. Firstly, is accessibility; communities living near rich sources of medicinal plants have easy access to these natural remedies (Muhammad Fuad, et al., 2021, Mbuni, et al., 2020). This accessibility encourages their daily use in treating common ailments, thus maintaining traditional health practices. Secondly is a knowledge transmission. Proximity to diverse plant species facilitates the sharing of knowledge among community members (Saupi et al. 2020, Slik et al. 2009). Elders often pass down their understanding of medicinal plants, ensuring that traditional knowledge is preserved and utilized in daily life.

Thirdly is a sustainable practice. The local belief systems regard the forest and its resources as sacred (Maru et al., 2022; Mulyadi et al., 2022). As such, the sustainable harvesting of medicinal plants is a common practice, ensuring that the resources are available for future generations. This practice reinforces the connection between the community and their environment. Finally, integration into modern healthcare (Negahban et al. 2018). In recent years, there has been a growing interest in integrating traditional medicine with

modern healthcare practices. Local clinics and hospitals sometimes incorporate the use of medicinal plants, particularly those sourced from nearby locations, thereby bridging traditional wisdom with contemporary medical practices.

In the case of Bidayuh Bukar-Sadong communities in Serian, the location of medicinal plant sources significantly influences the pattern of the medicinal plants used for the villages with distances more than 15 kilometres from the nearby towns. Figure 4.8 shows Kampung Tian Mawang and Kampung Murud Mawang, the two villages with the most respondents willing to share their traditional plant medicinal knowledge, with 53.8% and 50% respectively. The surrounding areas of the two villages are still connected to the forests (approximately within 5 km radius). Those forests (although some are patches of secondary vegetation) are very important as a source for their medicinal plants.



Figure 4.8: Location of medicinal plant source – Kampung Tian Mawang and Kampung Murud Mawang (Source: Google Map)

Additionally, two villages about 1 – 3 km away from the Serian town, Kampung Apungan and Kampung Ranchan also showed a significant pattern of the use of traditional medicinal plants (Figure 4.9). The result agreed with Mohd Fuad et al., (2021), and, Mbuni et al. (2020), on the accessibility influenced the use of medicinal plants. Due to the short distance to the Serian town, where the health care centre is available 24 hours, and, the

pharmacy and shops supply modern medicines, the number of local villagers who practice traditional medicines is very low, only 20.5% for Kampung Apungan and 23.1% for Kampung Ranchan. Those two villages are also closed to the forests (Mount Apungan – Kampung Apungan, and Ranchan Recreational Park – Kampung Ranchan), and can be assessed easily to search for medicinal plants, but the local are preferable for modern medicines.

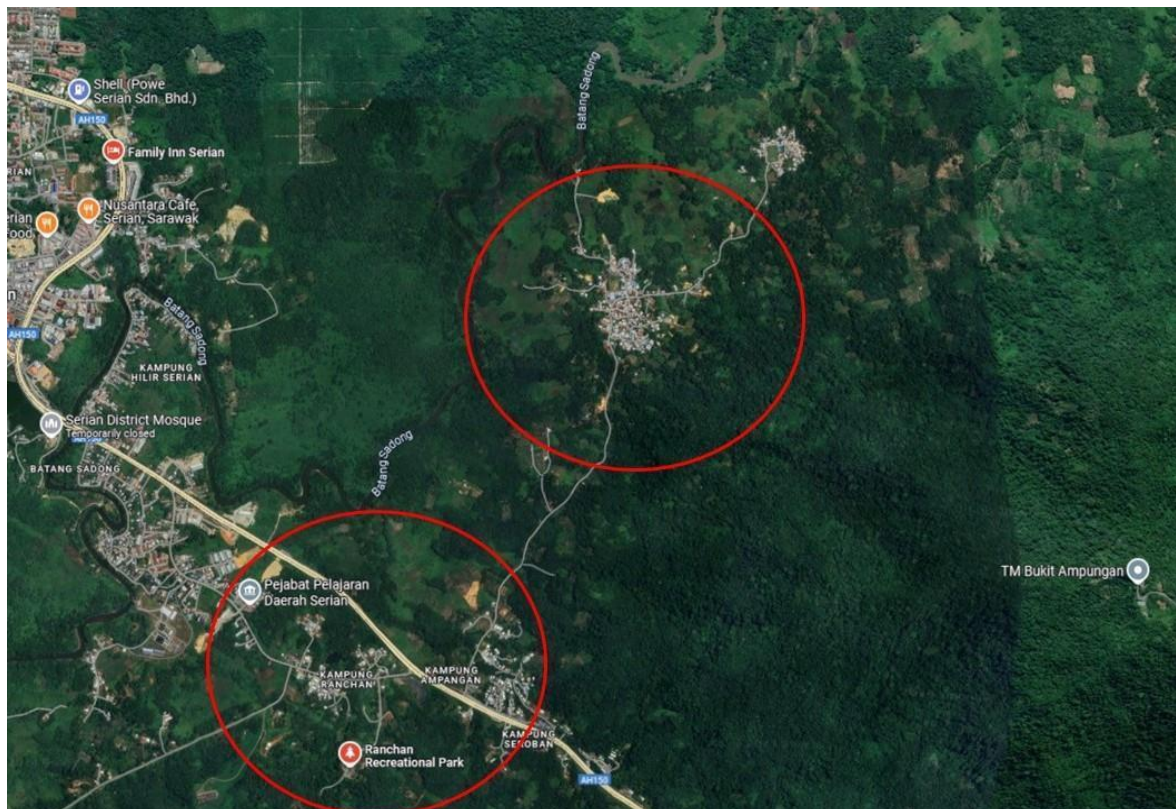


Figure 4.9: Location of medicinal plant source – Kampung Apungan and Kampung Ranchan (Source: Google Map).

Importance of Forest as Traditional Needs

The forests of Sarawak are home to an incredible variety of plant species, many of which possess medicinal properties. Indigenous communities have long relied on these plants for their health needs, utilizing their deep-rooted traditional knowledge to treat various ailments. For generations, the Bidayuh, Iban, Melanau and other ethnic groups have harnessed the healing potential of local flora, often preparing remedies from leaves, roots, and barks. This traditional knowledge is invaluable, as it represents a rich cultural heritage that promotes sustainable practices and a profound understanding of the ecosystem.

The survey was also conducted to investigate the perception of respondents (870 individuals) on the importance of forests as their traditional needs (foods, medicines, cultural and spiritual) sources. The results as shown in Figure 4.10 and Figure 4.11.

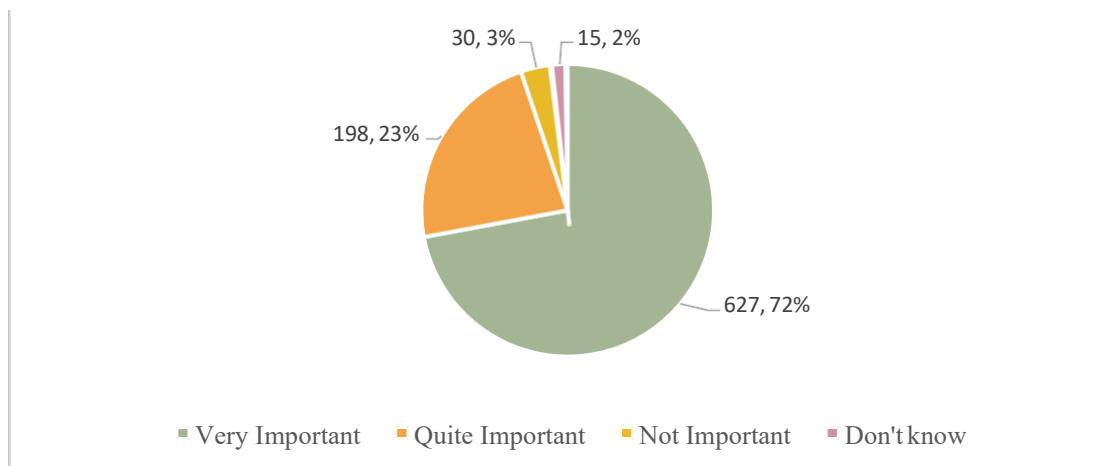


Figure 4.10: Importance of forest for health (Food and Medicines).

About 95% (825 respondents) agreed that forests are very important for the local communities, particularly in Sarawak, as sources of food and traditional medicines. These include, 627 individuals impressed with very important, and 198 others with, quite important. Whereas, 30 individuals feel that the forests are not longer important for foods and medicines, while 2% of the respondents under the “did not know” category, including

those who were not willing to give any comments. The scenario agreeable with the study by Meijaard et al., (2013) stated that perceived values of forests among the local were generally high, with especially the importance of forests for health and cultural and spiritual purposes.

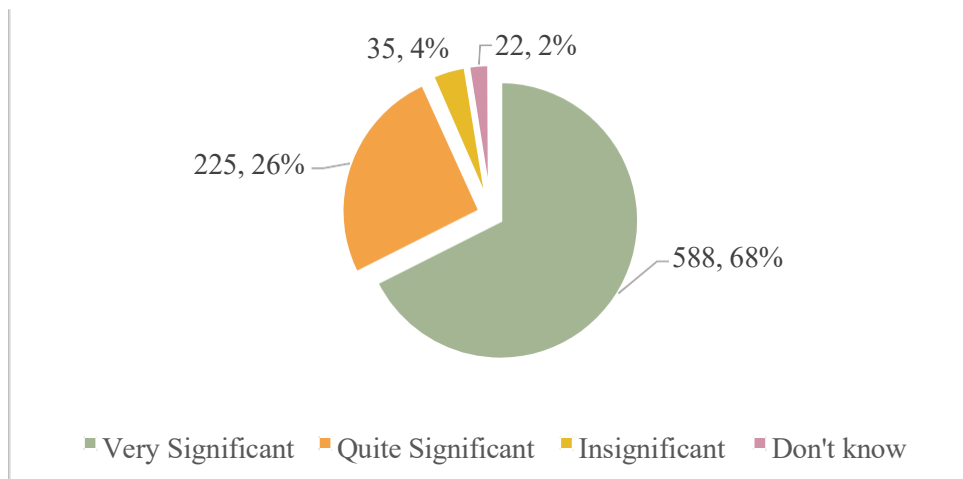


Figure 4.11: Significance of forests for cultural and spiritual benefits

For the significance of forests for cultural and spiritual benefits, most of the respondents agreed that the forests are still significant (66% - very significant and 26% - quite significant) for the local communities in Sarawak, and the Bidayuh Bukar-Sadong especially. Only four and two per cent feel that the forests are insignificant and did not know, respectively.

The forests of Sarawak are of paramount importance as sources of medicinal plants. They embody a rich tapestry of biodiversity and traditional knowledge that contributes to health, cultural identity, and scientific advancement. The integration of traditional practices with modern research can foster the sustainable use of these resources, ensuring that the medicinal potential of Sarawak's forests is preserved for future generations.

4.2.2 Medicinal Documentation

Traditional Uses/Treatment (Medicinal)

A total of 71 diseases or treatment-based on local remedies in the Bidayuh Bukar-Sadong traditional medicines from Serian. Most of the plants used are for external usage (70%) and only 30 per cent of types of diseases/treatments need by consumption of the plant parts or juices. All 71 ailments were grouped into four major types, viz. relief pains, internal treatments, external treatments and ritual and religious (Figure 4.12).

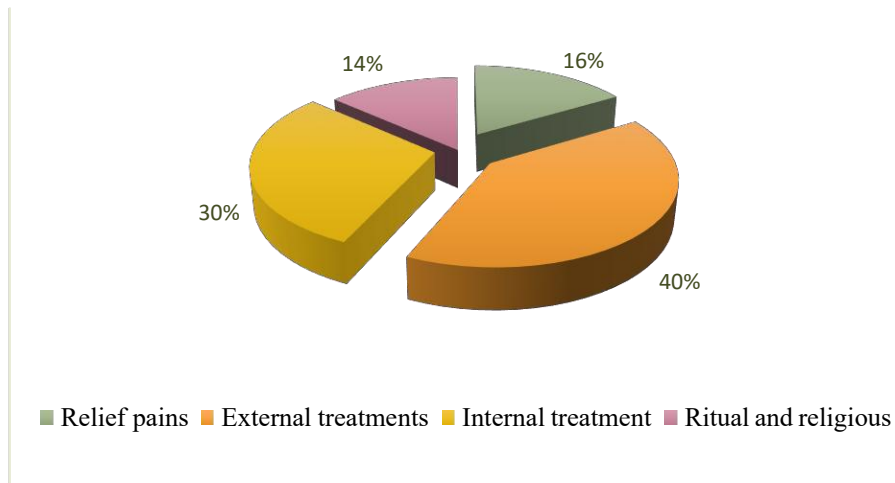


Figure 4.12: Four major types of ailments (based on respondents)

Table 4.3 below shows details of ailments and their major group. The major groups are relief pains, external treatment, internal treatment and ritual and religious. The group ritual and religion includes all the beliefs and thoughts related to the soul, spirit, evil and environment. For example, the practitioners believed that a bad dream might lead to bad luck for the day. To prevent bad luck from happening, the practitioners will consume or use plants for good luck.

Table 4.3: Four major groups of ailments (based on respondents)

Relief pains	External treatment	Internal treatment	Ritual and religious
<ul style="list-style-type: none"> • Body pain • Spleen pain • Chest pain • Pubic pain • Waist pain • Joint pain • Shoulder pain • Veins pain • Nerves pain • Bladder pain • Sudden pain 	<ul style="list-style-type: none"> • Wound/cut • Skin itchininess • Swelling • Sprains • Breast swelling • Snakebite • Bee sting • Fracture bone • Jaundice • Chickenpox • Migraine • Burned • Numb • Insomnia • Antidote • Shingles • Red eyes • Fungus • Ringworms • Fever • Gout • Scabies • Boils • Dandruff • Sore eyes 	<ul style="list-style-type: none"> • Gastric • Stomach-ache • High blood pressure • Cough • Dengue • Mouth ulcer • Urination problems • Cancer • Asthma • Lymph node • Constipation • Gallstones • Measles • Diabetes • Detox • Difficult to conceive • Confinement • Vomiting • Toothache 	<ul style="list-style-type: none"> • Loss soul • Bad dream • Disturbed by evil spirit • Non-stop crying (baby) • Allergic sago worm • Billycock • Gages • Low immunity (baby) • Skinny baby

Plant Part used

The indigenous communities of Sarawak, including the Iban, Bidayuh, and Orang Ulu, possess a deep understanding of their natural environment. Traditional medicine is intertwined with their cultural practices, spirituality, and social life (Mat-Salleh & Latiff, 2002). The use of plants for healing purposes is often accompanied by rituals, prayers, and the passing down of knowledge through generations (Sutomo et al., 2024). This holistic approach reflects the belief that health is not merely the absence of illness but a balance between physical, spiritual, and emotional well-being (Borneo Research Bulletin, 2019). The local peoples, in this case, the Bidayuh Bukar-Sadong have been utilizing plants for many years, and they knew that every part of plants had different functions to treat different ailments or illnesses.

Part of the plant used in the medicinal practises by the Bidayuh Bukar-Sadong is shown in the pie chart (Figure 4.13) below. About half or 54 per cent of the part used are under the category leaves (includes leaves, young leaves and shoots) followed by the fruits category with 13 per cent. Only one species each for the categories latex, thorns and seeds were recorded. The latex of *Alstonia angustiloba* is used to treat skin diseases, and the seeds of *Kacang lanir* (*Abelmoschus esculentus*) are to treat jaundice. Five plant parts (rhizomes, stems, barks, cabbage and whole plant) with five per cent each, while roots and flowers with two and three per cent respectively.

The result of plant parts used is agreeable with most ethnomedicine studies all over the globe, where the leaves/shoots and roots categories are the most popular parts used by traditional medicine practitioners (Qamariah et al., 2020; Rahmatullah et al., 2010, Wondimu et al., 2007). It is a modest reason; leaves/young leaves/shoots are always

available throughout the years. Furthermore, they are easier to collect, process and apply compared with other plant parts.

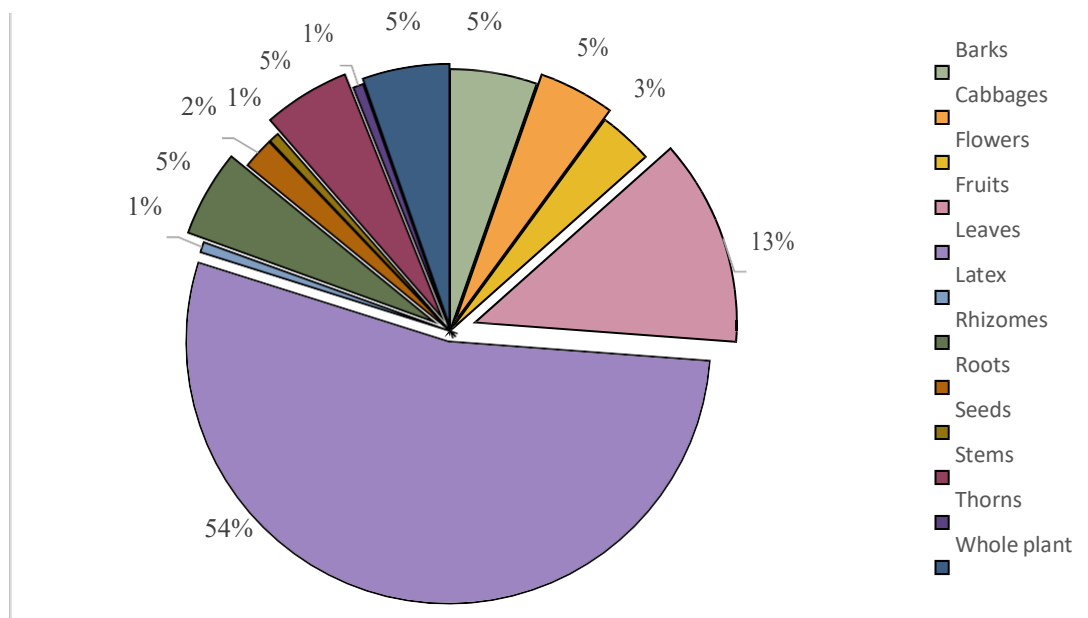


Figure 4.13: Part of the plant used in the medicinal practises by the Bidayuh people in Serian

Leaves are not only vital for the plant's survival through photosynthesis but also serve as a reservoir of nutrients and medicinal compounds. They contain essential vitamins, minerals, and phytochemicals that can promote health and well-being. For instance, the leaves of *Moringa oleifera* are celebrated for their high nutritional content, including vitamins A, C, and E, as well as calcium and iron. This nutritional profile makes them a popular choice for enhancing overall health and combating malnutrition, particularly in rural areas where access to diverse food sources may be limited (Verman et al., 2023), and the most important is they are available throughout the year. In Sarawak, local communities, including the Bidayuh Bukar-Sadong have harnessed the healing properties of leaves for generations, relying on their extensive knowledge of plant-based remedies to address a wide range of health issues.

The Bidayuh Bukar-Sadong community believed that various leaves are employed for their specific medicinal properties. For example, the leaves of *Andrographis paniculata* (*Hempedu bumi*) are commonly used to treat fevers and respiratory infections. The bitter taste of the leaves is believed to have detoxifying effects, making them a popular choice for cleansing the body. Similarly, the leaves of *Piper sarmentosum*, known locally as *Kriih* are used in traditional dishes and are believed to have anti-inflammatory and analgesic properties, making them effective for treating minor aches and pains. The preparation of medicinal leaves often involves simple methods such as boiling, infusing, or crushing. For instance, leaves may be brewed into teas or decoctions, allowing the active compounds to be extracted and consumed. In some cases, leaves are crushed and applied topically as poultices to treat skin conditions or wounds. This versatility in preparation methods highlights the adaptability of traditional practices to meet various health needs.

The use of leaves in traditional medicine is deeply embedded in the cultural practices of Sarawak's indigenous communities (Rajoo et al. 2023). The knowledge of which leaves to use and how to prepare them is often passed down through generations, reflecting a rich heritage of botanical wisdom. This cultural significance is not only about healing but also about maintaining a connection to the land and the environment, reinforcing the community's identity and values.

The second highest plant part being used for ethnobotanical purposes by the Bidayuh Bukar-Sadong communities is fruit, which is about 13% of the total number of species recorded (Figure 4.2). The result showed a significant similarity with other ethnics in Sarawak such as Rajoo et al., (2023) for the Kenyah community, Patrick et al. (2022) for Bidayuh Padawan, Martin (1997) and Baling et al., (2017) for Bidayuh Bau, and, Jackson

et al., (2006) for Iban. Communities have developed a comprehensive understanding of which fruits can be used to treat specific ailments, often passed down through generations (Halim et al., 2012). This knowledge not only aids in health-seeking behaviour but also fosters a connection to the local ecosystem (Nelson, 2022). The use of medicinal fruits is intertwined with the cultural practices of various ethnic groups in Sarawak, such as the Bidayuh, Iban and Melanau communities (Forest Department Sarawak, 2019). These groups have documented the traditional uses of over 1,300 plant species, including fruits, which are often used in local remedies and health practices (Forest Department Sarawak, 2024 onwards).

Roots and rhizomes play a significant role in traditional medicine in Sarawak. For instance, the roots of *Curcuma longa* are used not only as a spice but also for their anti-inflammatory properties. The Bidayuh Bukar-Sadong healers apply turmeric paste to wounds and skin conditions, and the root is also consumed for its potential benefits in digestive health. This dual use highlights the versatility of plant parts in local therapeutic practices. About 11 species of medicinal plants (the majority from the family Zingiberaceae) used by the Bidayuh Bukar-Sadong communities in Serian were recorded during this study. *Kunyit* (*Curcuma longa*) and *Laih grane* (*Zingiber officinale*) were the two most common plants used for the rhizome part.

Plant barks and stems are also commonly used in traditional medicine (Feyisa et al., 2024; Parkash et al., 2018). For example, willow bark (*Salix* spp.) contains salicylic acid, the active ingredient in aspirin, which is used to relieve pain and reduce inflammation, and, arthritis (Lin et al., 2023). Plant stems like liquorice are used to treat respiratory conditions and digestive issues (Chen et al., 2024). In Borneo, the barks and stems of certain plants are often used for their antimicrobial, anti-inflammatory, and analgesic properties (Galappathie et

al., 2014). The Bidayuh Bukar-Sadong communities in Serian employed specific bark of plant species to treat wounds and infections, while others such as *Sikog* (*Garcinia mangostana*) and *Lase* (*Lansium domesticum*) may be used to alleviate pain or reduce inflammation.

The preparation of medicinal remedies often involves boiling or infusing the barks and stems to extract their beneficial compounds. The preparation can be consumed as teas, applied topically, or used in ritual.

In Sarawak, local communities utilize a variety of flowers for their medicinal properties, reflecting a rich tradition of ethnobotanical knowledge passed down through generations (Fauziah et al., 2023). Flowers are often valued for their anti-inflammatory, antiseptic, and analgesic properties (Cruz et al., 2023). They are used in various preparations, such as infusions, poultices, and topical applications, to treat ailments ranging from skin conditions to respiratory issues. The preparation of medicinal flower remedies typically involves boiling the flowers to create infusions (Ernst., 2010) or crushing them to extract their juices. These preparations can be consumed as teas or applied directly to the skin for various therapeutic effects. For this study, only three per cent out of 126 plant species were used for flower therapeutics by the Bidayuh Bukar-Sadong in Serian. The result, however, showed slightly higher than as reported by Fauziah et al., (2023), with only two species.

Plant latex ingredients are a treasure trove of highly concentrated, thus partially purified active substances (Konno., 2011), such as potential medicines, toxins, and other bioproducts, which plants produce initially to defend against herbivores and pathogens (Cruz et al., 2018). The medicinal applications of plant latex are diverse. For instance, latex from certain plants such as *Euphorbia hirta* (*Gelang susu*) is known for its antimicrobial properties, making it useful in treating cuts and wounds. Indigenous healers often apply the latex directly to the affected area, taking advantage of its natural healing qualities. Additionally, some

communities use latex for its analgesic effects, providing relief from pain and inflammation. In traditional medicine, plant latex is sometimes mixed with other natural ingredients to create potent remedies. For example, it may be combined with herbal extracts to enhance its efficacy. This holistic approach to medicine demonstrates the intricate knowledge local communities possess about their natural resources and their ability to blend various elements to create effective treatments. In the case of Bidayuh Bukar-Sadong communities in Serian, the use of latex for medicinal purposes was rarely practised. According to the respondents (99%), the use of latex is unpopular due to its sticky characteristic and concern that it might harm their skin.

Religious ceremonies and practices have long shaped human perceptions and interactions with the environment. Plants, in particular, play an important role in rituals and socio-religious behaviours, adding cultural and historical richness to these relationships (Chaachouay & Zidane., 2021). Another unpopular plant part being used by the local communities in Sarawak is thorns or prickles. During the survey for this project, only one species was recorded for this purpose. The prickles from the *Salak* plant (*Salacca* sp.) are believed to remove or cast-off a bad luck on that day (after having a nightmare – dreaming about the dead person).

4.3 Methods of Preparation (Based on Respondents)

Traditional medicines have been utilized for centuries to treat various ailments in numerous cultures worldwide. These medicines come in various forms ranging from powdered herbs, tinctures, decoction and others. One of the fascinating aspects of traditional medicines is the methods of application used to deliver them into the body. There were two types of application documented in this study, i.e. for external use or internally .

Table 4.4: Method of preparation (Based on Respondents)

External use	Details
Heated and crushed	This method often involves applying heat to ingredients, which can enhance flavours and make them easier to digest when applied externally, such as in poultices for skin ailments.
Pasted	Creating a paste can be useful for applications, such as ointments or masks, which can soothe or heal the skin.
Crushed and squeezed	Typically used to extract juices or oils from ingredients, which can be applied externally for their therapeutic properties.
Boiled for bath	Boiling ingredients for a bath can infuse the water with beneficial properties, such as relaxation or skin nourishment.
Burn and step on	This method refers to using heated materials for therapeutic foot baths or treatments, but it requires caution.
Shredded	Shredding can increase the surface area of ingredients, making them more effective in applications.
Scraped	Scraping can be used to prepare ingredients for external applications, such as scrubs or exfoliates.
Internal use	Details
Chewed	Chewing food is a fundamental method of preparation that aids in digestion and allows for the release of flavours and nutrients.
Boiled and gargle or drink	Boiling ingredients for gargling or drinking is common for remedies, such as soothing sore throats or digestive issues.
Eaten raw as salad	Consuming ingredients raw preserves their nutrients and enzymes, which can be beneficial for health.

Table 4.4 continue

Blended as juice	Blending ingredients into juice allows for easy consumption of nutrients and can be refreshing and hydrating.
Sliced and eaten	Slicing ingredients can make them more palatable and easier to digest, enhancing the eating experience.
Fried and crushed	Frying can enhance flavours and textures while crushing can make the food easier to consume or incorporate into dishes.

A total of 13 methods of preparation on how to use the medicinal plants among the Bidayuh community in Serian were documented for this study. The methods were divided into two types, based on the purposes and application; either it was used externally or internally. External use refers to the plants (as whole, parts or processes) that are applied on the skins (externally) to treat or heal pains or diseases. Internally used refers to the plants (as whole, parts or processes) that are eaten raw or consumed through the various processes.

The results showed a different scenario from others, in which most of the types of methods of application documented were normally for external use, e.g. Meekiong et al. (2021), Ong et al. (2010, 2011, 2012), Bau and Poulsen (2007) and Ripen and Noweg (2017). According to the respondents (those who were not willing to share – 13.7%: Table 4.4 above), many of the plants used by the Bidayuh Bukar-Sadong in Serian are for consumption (either for *ulam* or medicine), and they felt that was unsafe to shared information because of their lack of knowledge on plant identification. This is supported by many studies by others, e.g. Ekar and Kreft., (2019); Zhang et al., (2015), and Lanini et al., (2012). For external use, the most common methods of applications were pasted, heated crushed and boiled for bath.

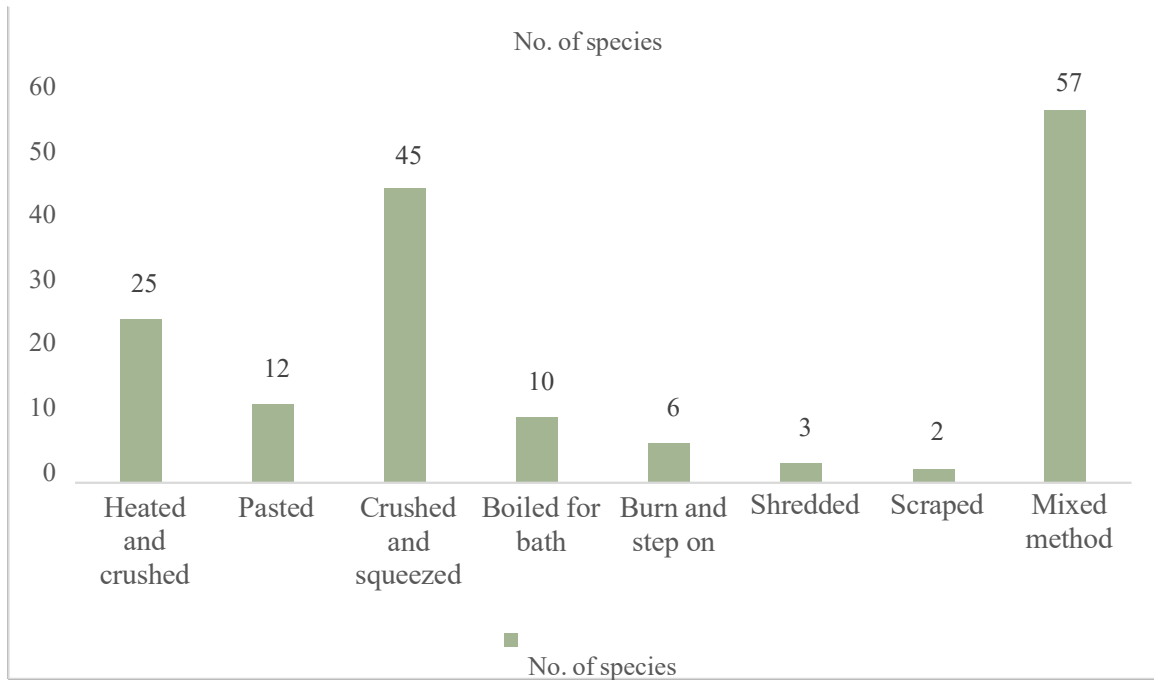


Figure 4.14: Number of medicinal plant species based on the method of preparation for external use

Figure 4.14 shows the number of medicinal plant species based on the method of preparation for external use. The mixed method (e.g. heated, crushed and pasted, crushed, squeezed and boiled for bath, etc.) is the most prevalent, with 57 plant species recorded, followed by crushed and squeezed (45 species) and heated and crushed (25). The least common methods are scraped and shredded with three and two respectively. The graph highlights the diversity in processing methods applied to species, with a clear preference for the "mixed method." Understanding why certain methods are more popular could provide insights into their effectiveness or the specific requirements of different species (Chen et al. 2016).

For internal use, six methods of preparation by the Bidayuh Bukar-Sadong communities in Serian were documented during the study. The methods include, (i) chewed, (ii) boiled and gargled or drunk, (iii) eaten raw as salad, (iv) blended as juice, (v) sliced and eaten, and, (vi) fried and crushed.

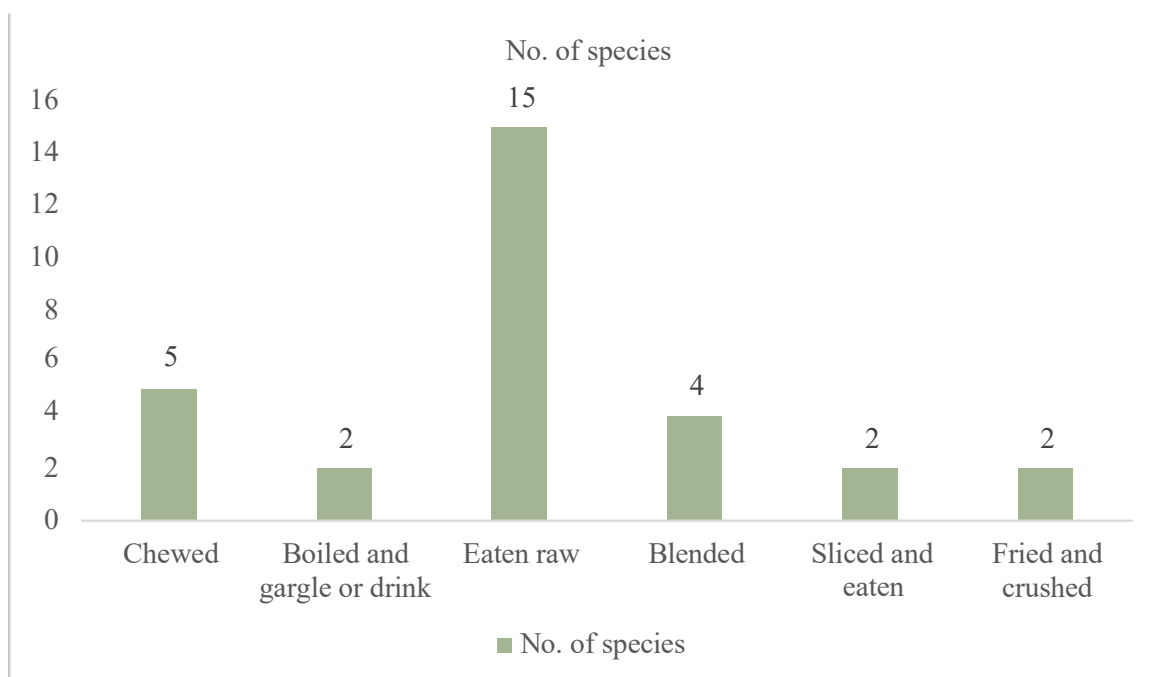


Figure 4.15: Number of medicinal plant species based on the method of preparation for internal use

Only 30 plant species were documented being used by the Bidayuh Bukar-Sadong communities in Serian for internally use. The practice of eating fresh and raw of plant parts or vegetable called *ulam* (Faridah et al. 2006), is also a common practise traditionally by the local ethnics in Borneo (Awang-Kanak & Abu Bakar, 2020; Normiadilah & Noriah, 2012) whose livelihood surrounded by nature (Abdullah & Go, 2009). The “*ulam*” was the most popular category by the Bidayuh Bukar-Sadong in Serian. Despite the most popular

method of preparation, the Bidayuh Bukar-Sadong communities, however consumed only plants that are reported safe to be eaten, such as *Centella asiatica* (Pegaga), *Cosmos caudatus* (Ulam raja), *Curcuma longa* (Kunyit) and *Parkia speciosa* (Petai). Many elders informed that they never dare to try to consume unidentified plants (exotic or introduced plants), unless it is safe to do so.

Figure 4.16: *Parkia speciosa* (Petai)



Among all the six methods of preparation by the Bidayuh Bukar-Sadong in Serian, boiled and gargled or drink was the only true preparation used to treat the illness, for sore throat or digestive problem. While, others methods of preparation were mostly consumed as food or drink.

4.4 Descriptions of Selected Plant Species

Allium cepa L.

Family:
Amryllidaceae

Vernacular name: Bawang bidaya (Bid. Ser.); Onion, Bulb onion (Eng.); Bawang merah (Mal.)

Synonym: *Allium angilense* Baker; *A. aobanum* Araki; *A. ascalonicum* auct.; *A. ascalonicum* var. *condensum* Millan; *A. ascalonicum* var. *fertile* Millan; *A. ascalonicum* var. *sterile* Millan; *A. ascalonicum* f. *rotterianum* Voss ex Becker; *A. bifolium* Alef.; *A. crinides* Alef.; *A. esculentum* Salibs.; *A. flandricum* Alef.; *A. napus* Pall ex Kunth.; *A. salota* Dostal; *Cepa alba* P. Renault; *C. esculenta* Gray; *C. vulgaris* Garsault; *Kepa esculenta* Raf.; *Porrum cepa* (L.) Rchb.

Distribution: Origin from Iran, western Pakistan and central Asia (Cumo, 2015). Now widely distributed throughout the world, planted as cash crops or ornamental.

Description: A biennial herb, bulb present, up to 50 cm tall. Roots adventitious, 1-2mm in diam., 10-25 cm long. Stem short c. 3 – 20 mm (or slightly longer), flattened, formed at the base of the plant in the form of a disk; pseudo-stem formed by the sheathing bases of successive leaves. Leaves 3-8, alternate, distichous, glaucous, produced in succession from the broadening stem apex, each arising as a ring which elongates to form the tubular leaf sheath; leaf-blade cylindrical, light to dark green, hollow, erect or slanting. Bulb formed by the thickening of leaf-bases a short distance above the true stem; as the result of the rapid

formation of lateral bulbs or shoot, clusters of 3-18 bulbs or shoots, clusters of 3-18 bulbs of the first and second order are formed; protective bulb coat-leaves purplish, brownish or white; mature bulbs oblong, globular or oblate, up to 5 cm in diameter, very various in shape, size, colour and weight. Scape 1 to several, up to 65 cm long, erect, straight, terete, at first solid, later becoming hollow. Inflorescence a spherical umbel, 2-8 persistent papery bracts; umbel with 50-2000 individual hermaphrodite flowers; pedicel slender; flowers sub-campanulate to urceolate; tepals 6 in 2 whorls, ovate to oblong, 3-5mm long, greenish-white; stamens 6; ovary superior, 3-locular, style simple, shorter than stamens anthesis. Fruit a globular capsule, 4-6 mm in diameter, splitting loculicidal, containing up to 6 seeds. Seed about 6 x 4 mm, black, wrinkled.

Specimen examined: Sarawak, Serian Division, Kpg Sebemban, *Hidir Marzuki s.n.*
(Herbarium Universiti Malaysia Sarawak).

Part used: Bulb

Traditional use and preparation: Crush and mix with coconut oil and rub on blotted stomach. Bulb cut rub on the nail (fungus). Mix with *Piper betle* leaves, and sock in water, for a bath to relieve fever.

Notes: Chemical constituents such as polyphenols, flavonoids and anthocyanin. Preliminary screening of bioactive compounds for this study has detected phenol and emodin.

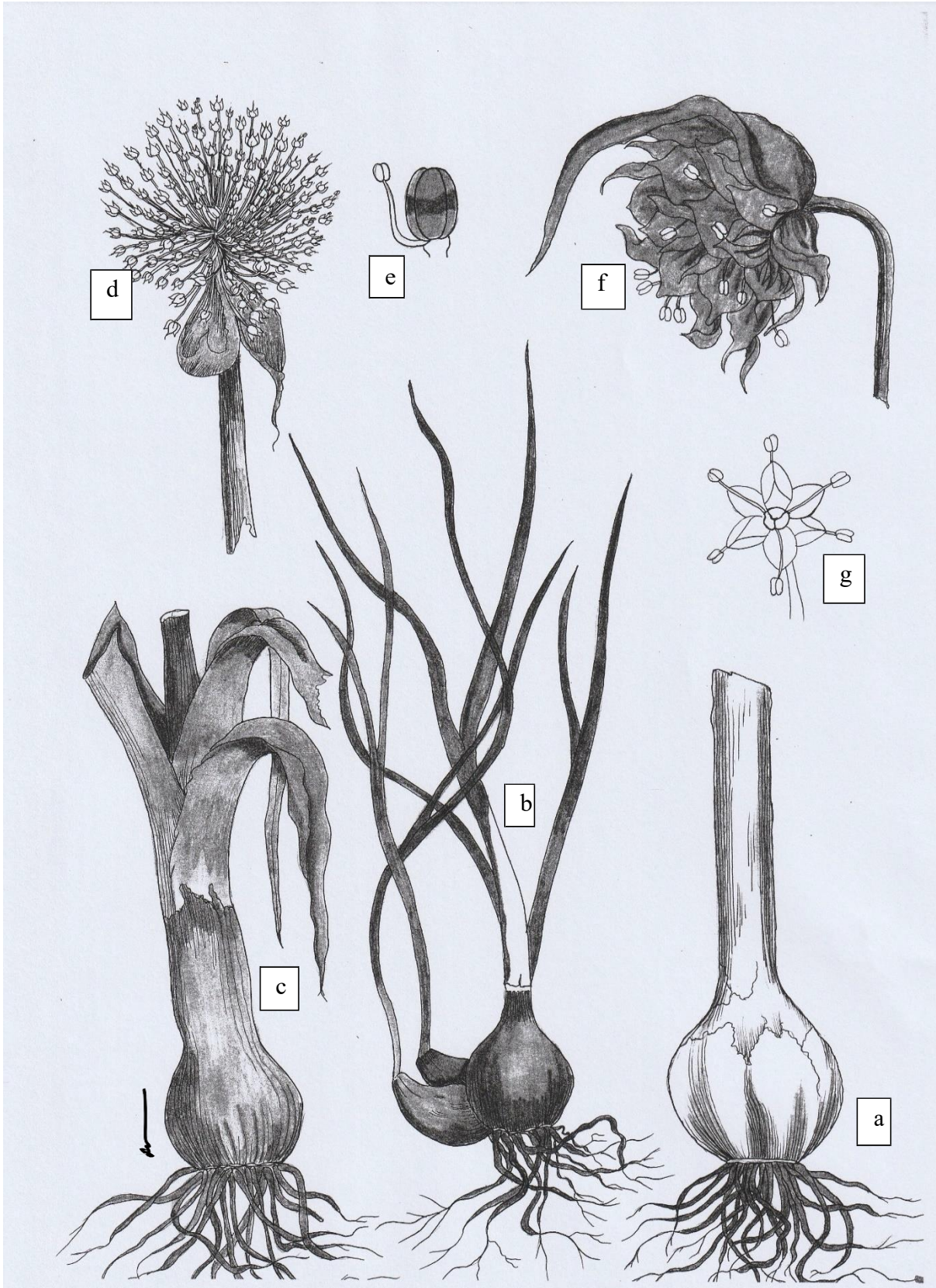


Figure 4.17: *Allium cepa* L. a). Bulb, b) young leaf, c). pseudo-stem, d) flowers, e). stamen, f). close up of flowers and g). petal

***Aglaonema simplex* (Bl.) Bl.**

Family: Araceae

Vernacular name: Kibang taruh (Bid. Bukar-Sadong), Sumpun bulan (Mal.), Borneo sword

Synonym: *Aglaonema alpinum* Elmer, *A. angustifolium* N.E. Br., *A. angustifolium* Ridl. var. *undulatum*, *A. birmanicum* Hook. f., *A. borneense* Engl., *A. brevivaginatatum* Alderw., *A. elongatum* Alderw., *A. emarginatum* Alderw., *A. grande* Alderw., *A. latius* Alderw., *A. longicuspidatum* Schott, *A. malaccense* Schott, *A. nicobaricum* Hook. f., *A. nieuwenhuisii* Engl., *A. subfalcatum* Engl., *Acontias fallax* Schott ex. Engl., *Caladium princeps* Kunth, *C. simplex* Bl., *Scindapsus tokinensis* K. Krause

Distribution: Native to Southern Myanmar, Thailand, Sumatra, Peninsular Malaysia, Java, Sulawesi, Borneo and the Philippines.

Description: Herb, 15 – 120 cm tall, stem erect, crown dense with narrowly oblong to linear lance leaves. Leaves alternate, dense and spirally arranged, narrowly oblong, or oval to lanceolate, or broadly elliptic, 10–35 x 1.9–25 cm, apex gradually sharp tip, petiolate, 2–10 cm long, blade leathery, green to dark green, midrib sunken above. The inflorescence is monoecious, erect enclosed within a light green to a whitish petal-like leaf that ends abruptly with a sharp tip, 2.5–7 cm, spadix ca. 5–7 cm long, spathe ca. 4–6 cm long. Fruit ellipsoid, greenish turned red at maturity.

Specimen examined: Sarawak, Serian Division, Kpg Apungan, Hidir Marzuki s.n. (Herbarium Universiti Malaysia Sarawak).

Part used: Roots and stem.

Traditional use and preparation: The stem and roots are used to treat diarrhoea symptoms. The stem and roots are boiled in water and drink. The Bidayuh people also used the latex (exudate) from the stem of *A. simplex* to treat wounds, atherosclerosis and hernia.

Notes: Mulyah and Sulistyaningsih (2022) and Ismail et al. (2017) reported the extraction of *A. simplex* containing secondary metabolites such as terpenoid, steroid, phenol, alkaloid and glycoside.



Figure 4.18: *Agloanema simplex* (Bl.) Bl. A: whole plant, B: fruits

***Alocasia longiloba* Miq.**

Family: Araceae

Vernacular name: Keladi Birah (Bid. Bukar-Sadong), Keladi rimau (Mal.), Birah kijang, Birah hitam, Elephant ears.

Synonym: *Alocasia denudata* Engl., *A. lowii* Hook. f., *A. singaporensis* Linden, *A. veitchii* (Lindl.) Schott, *Caladium veitchii* Lindl.

Distribution: South Yunnan, Guangdong to the west and Central Malesia (Peninsular Malaysia, Singapore, Sumatra and Borneo).

Description: Herb, small to robust plants, up to 150 cm tall with a thickened lower stem (corm), up to 50 cm long. Leaves alternate, stalked leaves have leaf blades that are arrow head-shaped, dark green above, light green or sometimes maroon below, blade 22–90 x 5–35 cm, with or without whitish veins, prominently seen at both surfaces. Petiole chocolate brown or greenish, usually mottled. Inflorescence about 6–25 cm long, peduncle 4–15 cm, greenish and usually mottled (similar to leaf petiole), flowers enclosed by a greenish to white coloured spathe, 9–10 cm long.

Specimen examined: Sarawak, Serian Division, Kpg Apungan, Hidir Marzuki s.n. (Herbarium Universiti Malaysia Sarawak).

Part used: Corm (rhizomes)

Traditional use and preparation: The corm (rhizomes) were mixed with other plants ingredients to be used by mothers after giving birth.

Notes: Terrestrial or lithophytic, occasionally found in primary forest, freshwater swamp and riverine.

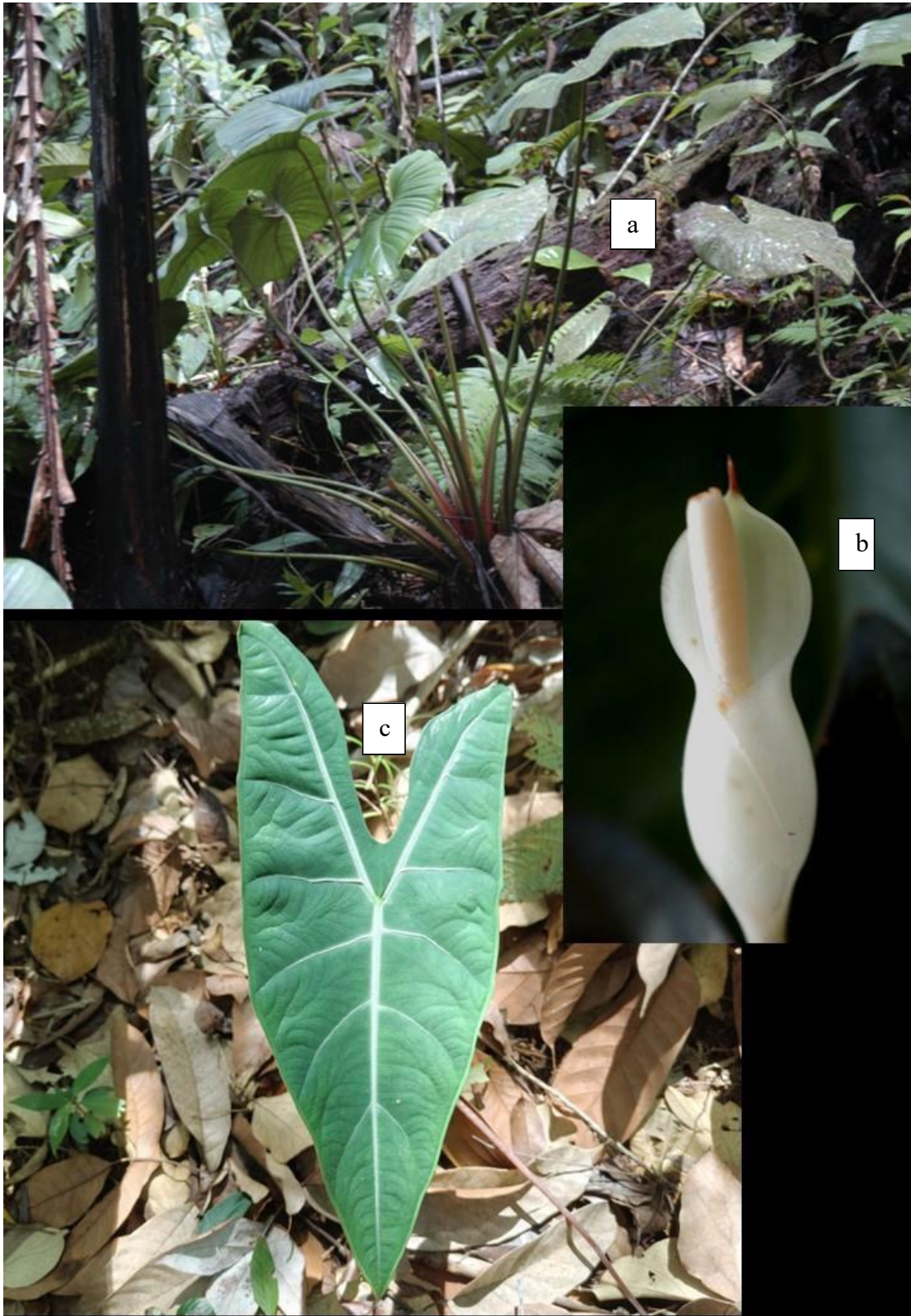


Figure 4.19: a). *Homalomena rostrata* (Tingud Aud), b). inflorescence of *Homalomena rostrata*, c). *Alocasia longiloba* (Keladi Birah)

***Homalomena rostrata* Griff.**

Family: Araceae

Vernacular name: Tingud Aud (Bid. Bukar-Sadong), Keladi kemoyang (Mal.), Kelemoyak (Mal.), Kemuyang (Ib.)

Synonym: *Chamaecladon sanguinolentum* (Griff.) Schott, *Cyrtocladon sanguinolentum* Griff, *Homalomena beccariana* Engl., *H. ensiformis* Alderw., *H. miqueliana* Schott, *H. paludosa* Hook. f., *H. propinqua* Ridl., *H. raapii* Engl., *H. ridleiana* Engl., *H. sagittifolia* Engl., *H. teysmannii* Engl., *H. triangularis* Alderw.

Distribution: South Peninsular Thailand, Peninsular Malaysia, Sumatra, Borneo and Maluku Islands.

Description: Herb, colony-forming stoloniferous with very strong aromatic, ca. 1 m tall, stem erect to creeping, ca. 20 cm long. Leaves in clusters, up to 20, petiole 10 – 50 cm long, blade deep green, glossy, broadly ovate-obovate, leathery, 10 -50 x 3 – 25 cm, apex acuminate to broadly obtuse. Inflorescence 2 – 3 together, subtended by a conspicuous prophyll, peduncle 8 – 15 cm long, robust, spongy, glossy bright red. Spathe flushed red, 5 – 15 cm, conspicuously constricted, spadix subequalling the spathe, up to 14 cm long. Fruits oblong-globose, dull red, smelling strongly of butyric acid.

Specimen examined: Sarawak, Serian Division, Kpg Ranchan, Hidir Marzuki s.n. (Herbarium Universiti Malaysia Sarawak).

Part used: Roots and stem.

Traditional use and preparation: The corm (rhizomes) were mixed with other plants ingredients to be used by mothers after giving birth.

Notes: Thriving well in the wet area in primary forests and orchads.

***Blumea balsamifera* (L.) DC.**

Family: Asteraceae

Vernacular name: Chuah (Bid. Ser.); Sambong (Bid., Ib., Mel.); Sembong (Mal.); Capa (Indon.); Capor (Mal.); Telinga kerbau (Mal.); Ai Na Xiang (Chi.)

Synonym: *Baccharis salvia* Lour.; *Blumea appendiculata* (Blume) DC.; *B. grandis* (Wallich) DC.; *Conyza appendiculata* Blume; *C. balsamifera* L.

Distribution and Ecology: Origin from tropical and subtropical zones in Asia, particularly southern India and Southeast Asia. This species is considered a weed, a ruderal species that often grows on disturbed land and opened spaces along the roadside.

Description: Evergreen shrub, up to 4 m tall, stem erect, 2–8 cm in diam., bark greyish brown, smooth, inner soft in white. Leaves simple, alternate in arrangement, lanceolate to oblong-lanceolate, 15–18 x 3.5–5 cm, apex acuminate, margin serrate with upcurved teeth or serrulate, base auriculate narrowed, adaxial rigid or wrinkled and covered with soft hairs, abaxial densely silky-cottony hairs. Petiole short, *ca.* 10–12 mm long. Inflorescences capitula or leads, terminal, producing a pleiochasium of 4 main peduncles, each main peduncle terminating in a pleiochasium and laterally bears 4–7 secondary peduncles below the pleiochasium, each peduncle bears a capitulum, campaniform; bracts involucre, corolla synpetalous, tubular, 5-toothed, yellow. Androecium 5-stamens, epipetalous, anthers ditheous, oblongoid, bases sagittate, syngenesious, exerted, introrsely, dehiscence longitudinal. Pistil 1, ovary inferior, 2-carpelled, syncarpous, 1-loculed with a solitary basal ovule, style 1, stigmatic branches 2, stigmas 2. Fruit an achene, sericeous, smooth, persistent pappus soft, pale pink.

Specimen examined: Sarawak, Serian Division, Kpg Murud Mawang, *Hidir Marzuki s.n.* (Herbarium Universiti Malaysia Sarawak).

Part used: All parts, including roots, stems, leaves and flowers.

Traditional use and preparation: Leaves heat and paste on the stomach to treat bloated stomach. Same as for the common cold, as a diuretic, for infected wounds, leaves crush and spread on wound area, respiratory infections and stomach pains, to treat asthma, leaves crush and mix with *Curcuma xanthorrhiza* and spread on the chase. Boil and drink to reduce high blood pressure. Sick and vomiting leaves crushed mix with salt and water and drink. Leaves sock in hot water for a bath for confinement and cold (fever). Leaves, tied with the white treat and small knife, spread over the body pain to remove the evil charm.

Notes: The plant produced a strong smell of camphor. An active chemical detected (in the volatile oil) such as blumeatin, camphor and limonene; borneol, saponin, sesquiterpene and tannin also traces in leaves of *B. balsamifera* (Boy et al. 2018).

Preliminary screening of bioactive compounds for this study has detected phenol and emodin.



Figure 4.20: *Blumea balsamifera* (L.) DC. a). leaf, b). flowers, c). close up of flowers, d). stamen and e). anthers



Figure 4.21: *Blumea balsamifera* (L.) DC. (Seedling)

***Vernonia arborea* Buch.-Ham.**

Family: Asteraceae

Vernacular name: Sinang hari (Bid. Ser.); Gambong, Medang gambong, Medang lempong, Menggabong, Merabong (Mal.); Tapong-tapong (Sabah); Entepong (Ib.); Chuang (Thai.); Nangi (Indo.).

Synonym: *Conyza acuminata* Wall. *invalid.*; *Fustula tomentosa* Raf. *illeg.*; *Gymnanthemum acuminatum* Steetz; *Leucomeris glabra* Blume ex DC. *invalid.*; *L. javanica* Blume ex DC. *invalid.*; *Vernonia arborea* var. *arborea*; *V. arborea* var. *blumeana* (DC.) Koord. & Valetton; *V. arborea* var. *glabra* Koord. & Valetton; *V. blumeana* DC.; *V. celenonia* DC.; *V. floescens* Elmer; *V. urdanetense* Elmer; *V. vaniotii* H. Lev.; *V. wallichii* Ridl.

Distribution and Ecology: Widely distributed from southern China to India, throughout Southeast Asia and Papua New Guinea. In a wide range of habitats, commonly found in disturbed forests, secondary forests, along the roadside, from the sea level up to 2200 m above sea level.

Description: Medium-sized tree, up to 15 m tall, bark brown or blackish; young branchlets cylindrical and velvety. Leaves alternate spiral, clustered at the ends of branchlets. Blades elliptic or slightly obovate, 8.5–19 x 4–11 cm, apex acute or acuminate, margin entire or sometimes distantly double-toothed, base wedge-shaped, lower surface velvety. Petiole 6–26 mm long, light brown, velvety. Inflorescence 41–51 cm long, in cluster, panicle cymes. Flowers bisexual, white or purple, 2 mm across; 5–6 flowers gather in a shortly stalked; flower head 6 mm across. Fruit is produced achenes (dry, indehiscent fruit) with a hairy pappus at one end. The achenes are 2–3 mm long, ribbed, 1-seeded, hairs are white, and 5–8 mm long.

Specimen examined: Sarawak, Serian Division, Kpg Murud Mawang, *Hidir Marzuki s.n.*
(Herbarium Universiti Malaysia Sarawak)

Part used: Whole plant, leaves and barks.

Traditional Use and Preparation: Leaves paste to rub on the itchy eyelid, apply on the wound or cut on the skin.

Notes: A common species in many disturbed forests (one of many reasons why this species is among popular plants for ethnobotanical use). In Indonesia, it is reported that the root of this species is used in the treatment of fever. Krishna Kumari et al. (2003) reported the presence of active compounds in this species. Preliminary screening of bioactive compounds for this study has detected carvocrol, phenol and emodin.

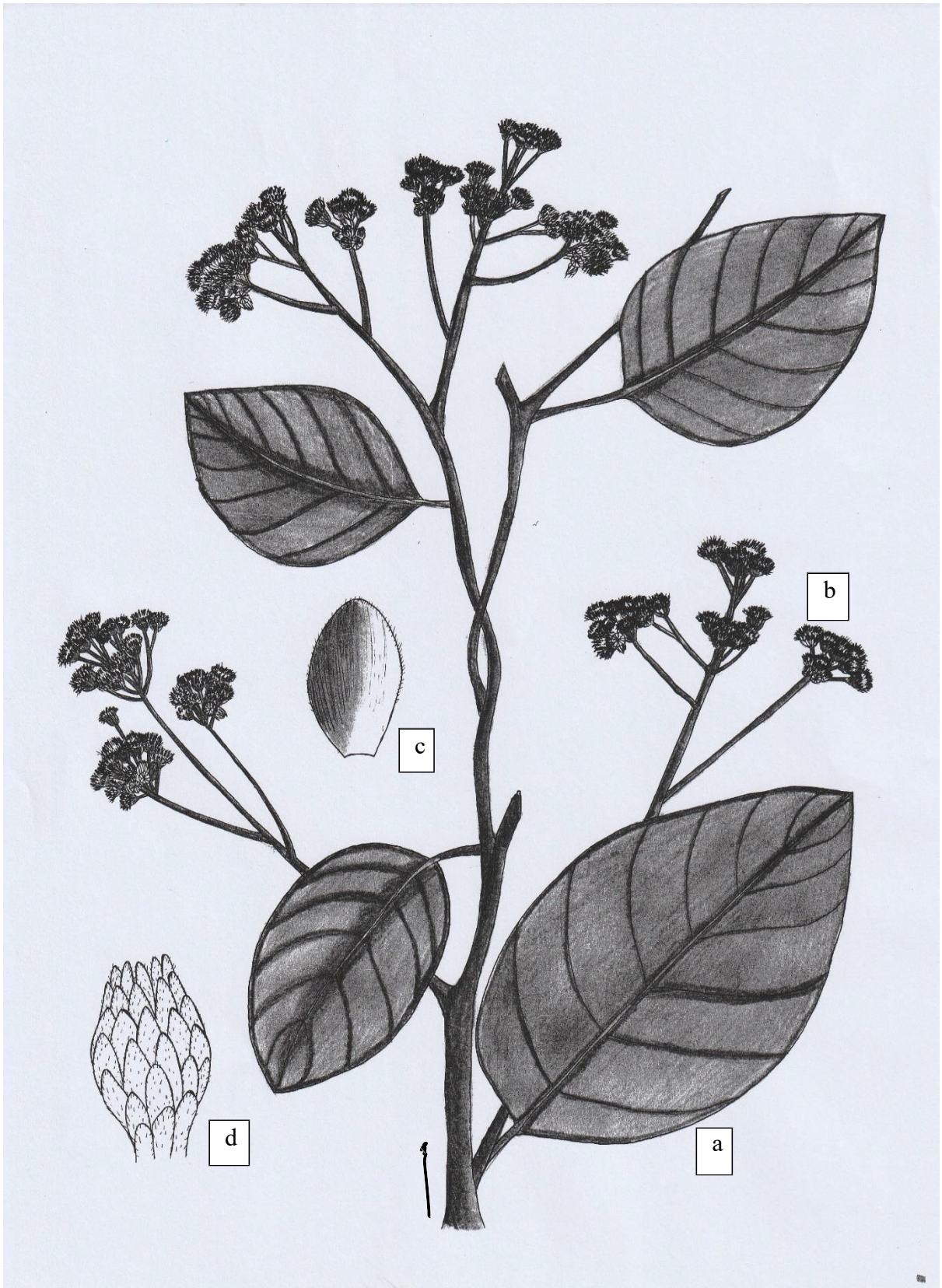


Figure 4.22: *Vernonia arborea* Buch.-Ham. a). leaf, b). flowers, c). petal and d). close up of flowers



Figure 4.23: *Vernonia arborea* Buch.-Ham. Herbarium specimen – No. Collection *Hidir Marzuki s.n.* (Herbarium of Universiti Malaysia Sarawak).

***Trema cannabina* Lour.**

Family: Cannabaceae

Vernacular name: Teberek (Bid. Ser.); Lesser Trema (Eng.); Menarong (Mal.)

Synonym: *Trema timorensis* Blume; *T. virgata* (Roxb. ex Wall) Blume

Distribution and Ecology: Distributed from Japan, China, tropical Asia, Australia, Papua New Guinea and the Pacific Islands. Commonly found at the edges of the forest, particularly disturbed forest, secondary forest and along logging roads.

Description: Shrub or small much-branched tree up to 6 m, bark smooth, greyish brown; branchlets slender, spreading, often drooping, densely silvery-hairy, glabrescent and sparsely lenticellate. Stipule linear-lanceolate, 5–7 x 1–2 mm. Leaves simple, alternate arrangement; blades 7–15 x 2–3.5 cm, apex acuminate, margins serrate, base rounded. Petiole 4–8 mm, slender, variously pubescent. Male inflorescences in the proximal leaf axil of branchlets. Female or androgynous inflorescences are distal. Male flowers pedicellate, ca. 1 mm in diam.; tepals 5, obovate. Drupes reddish-orange when mature, ± compressed, 2–3 mm in diam.; perianth persistent. Fruits small, drupe 3–5 mm in diameter

Specimen examined: Sarawak, Serian Division, Kpg Murud Mawang, *Hidir Marzuki s.n.* (Herbarium Univerisiti Malaysia Sarawak).

Part used: Leaves

Traditional use and preparation: Leaves are boiled for the bath to treat skin itchiness.

Notes: Fibre obtained from the bark is usually used as ropes and paper. The oil from the seed is normally used for making soaps and lubricants. Preliminary screening of bioactive compounds for this study has detected carvocrol and emodin.

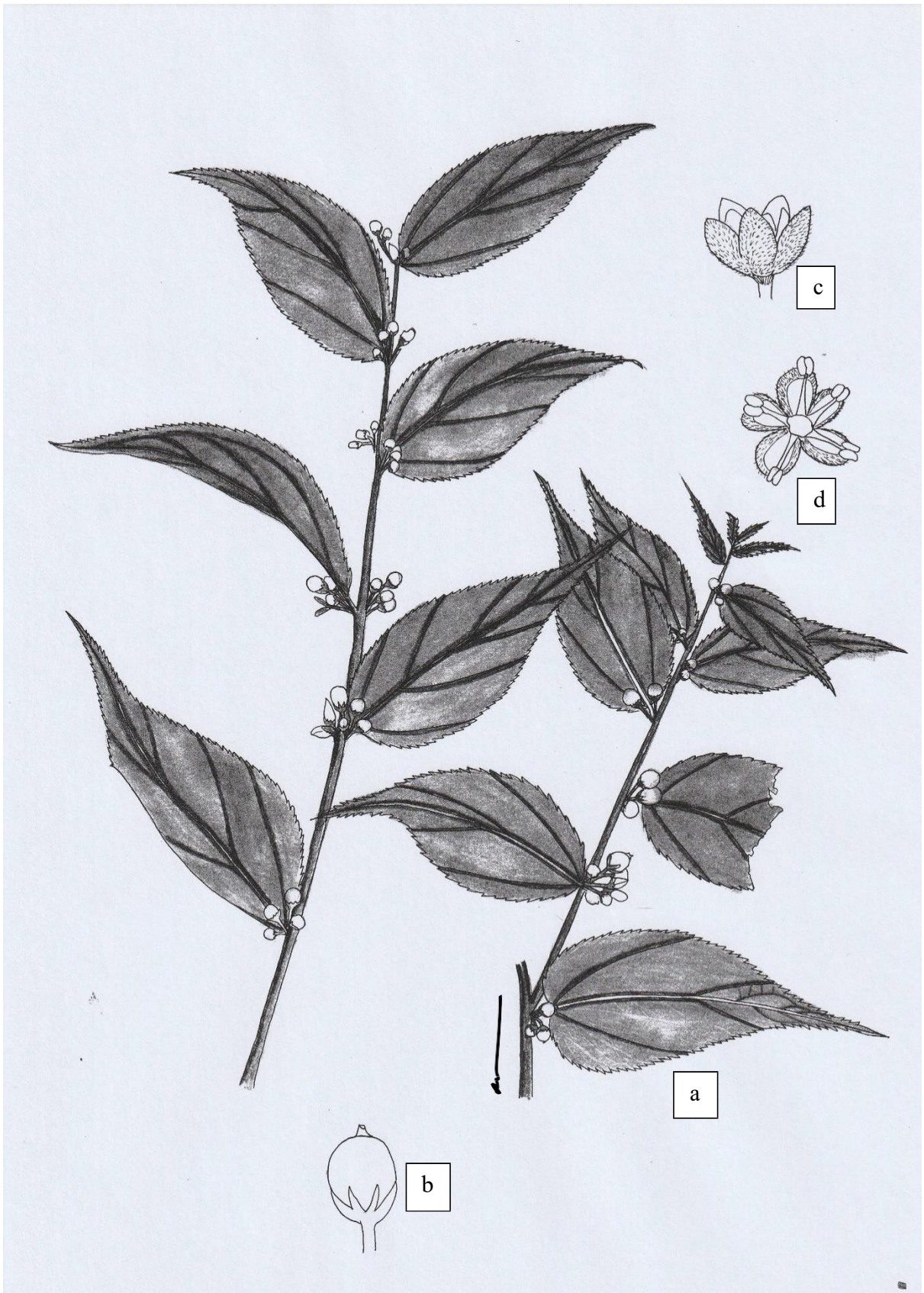


Figure 4.24: *Trema cannabina* Lour. a). leaf, b). fruit, c). flower and d). close up of flower



Figure 4.25: *Trema cannabina* Lour. Herbarium specimen – No. Collection *Hidir Marzuki* s.n. (Herbarium of Universiti Malaysia Sarawak).

***Garcinia mangostana* L.**

Family: Clusiaceae

Vernacular name: Sikok (Bid.); Manggis (Mal.); Mangosteen (Eng.)

Synonym: *Mangostana garcinia* Gaertn.

Distribution and Ecology: Widely distributed in Southeast Asia, India and tropical America.

The origin of this species is uncertain due to prehistorical cultivation. In a lowland forest, good drainage soils, are frequently found near streams or rivers.

Description: Small to medium-sized tree, up to 25 m tall; trunk straight, branched symmetrical, form a regular pyramidal crown. Bark smooth, grey-greenish, slashed inner bark pinkish, produce yellow latex. Leaves opposite, oblong to elliptic, 15–25 x 7–13 cm, apex cuspidate, margin entire, base cuneate, blades thickly leathery, olive-green on the upper surface, yellow to green beneath; both surfaces glabrous. Petioles are short, 5–10 mm long, clasping the shoot, so that the apical pair conceals the terminal bud. Flowers solitary or paired at apices of branchlets, short, thick pedicels, *ca.* 5.5 cm in diam.; sepals 4, arranged in 2 pairs; petals 4, thick, fleshy, yellow-green with reddish edges; staminodes many, 1-2 seriate, *ca.* 5 mm long; ovary sessile, sub-globose, 4-8 celled with prominent sessile 4-8 lobed stigma. Fruit globose, smooth, berry, 4-7 cm across, turning dark purple at ripening, sepals persistent, and still crowned by the stigma lobes; pericarp *ca.* 9 mm thick, purple; 0-3 of the cells containing a fully developed seed, enveloped by a white hooped.

Part used: The extract of mangosteen peels is traditionally used as a natural dye. According to a respondent from Kpg Mang Besi, the bark from the Sikok tree is used to treat body pains.

Traditional use and preparation: The extracted barks were crushed and spread or pasted on the body to relieve pain.

Notes: Known as “Queen of the fruit”, the Sikok plants are regularly planted as a cash crop for fruit. Now become a popular ornamental tree along the roadsides and gardens due to the crown shapes and low maintenance. In many places in Southeast Asia (e.g. Philippines, Indonesia, Peninsular Malaysia and Thailand), many parts of the mangosteen can be used to treat skin infections. Preliminary screening of bioactive compounds for this study has detected phenol and emodin.



Figure 4.26: *Garcinia mangostana* L. a). leaf, b). fruit, c). Cross section of fruit, d). flowers e). filamen, f). cross section of stigma, g). close up of flower and h). seed

***Mimosa pudica* L.**

Family: Fabaceae

Vernacular name: Uduh maya (Bid. Bukar-Sadong); Semalu (Mal.)

Distribution: Native to tropical America and now is a pantropical weed.

Description: Semi-woody herb, diffusely spreading, with branched stem (sometimes erect, up to 1 m tall), sparingly prickly with numerous deflexed bristly hairs. The leaves are very sensitive, both the pinnae and the leaflets closing when touched. The pinnate are usually 4, digitately arranged at the end of each petiole, 4 – 9 cm long. The leaflets are narrowly oblong, inequilateral, 1 – 1.5 cm long, sessile, sparingly bristly, with pointed tip. The heads are long-peduncled, solitary or 2 – 3 in each axil, nearly 1 cm in diam. The flowers are pink, numerous. The pods are flat, slightly recurve, numerous, 1 – 2 cm long made up of 3 – 5 one-seeded joints that at maturity fall away.

Specimen examined: Sarawak, Serian Division, Kpg Sebemban, Anna s.n. (Herbarium Universiti Malaysia Sarawak).

Part used: Whole plant and leaves

Traditional use and preparation: The root is administered (occasionally boiled) as diuretic, and is used against dysentery and dismenorrhoea. The juice of the leaves is used to impregnate cotton wool for dressing in any form of a sinus difficulty.

Notes: Rasadah et al. (2010) reported that the roots of *Mimosa pudica* contain tannin (10%) and ash (5.5%).



Figure 4.27: *Mimosa pudica* L. A: whole plant, B: stem C: fruits (pods) D: flower

***Senna alata* (L.) Roxb.**

Family: Fabaceae

Vernacular name: Gillige (Bid. Ser.); Gelenggang besar (Mal.); Tarum (Mel.); Emperor's candlesticks, Candle bush, Candelabra bush, Christmas candles, Empress candle plant, Ringworm shrub (Eng.)

Synonym: *Cassia alata* L.; *Cassia alata* L. var. *prennis* Pamp.; *Cassia alata* L. var. *rumphiana* DC.; *C. bracteata* L. f.; *C. herpetica* Jacq.; *C. rumphiana* (DC.) Bojer; *Herpetica alata* (L.) Raf.

Distribution and Ecology: Widely distributed throughout the tropical, subtropical and neotropics. Found in very diverse habitats from sea level to up 1200 m above sea level. Frequently found in the opened spaces in wet areas. Sometimes planted as ornamental or purposely in the backyard garden for medicinal use.

Description: Annual, occasionally biannual herb. The shrub average stands 3-4 m tall. Branches greenish, thick, pubescent. Leaves oblong, with 1-14 leaflet sets, 6-15 x 3.5-7.5 cm, thinly leathery, glabrous, base obliquely truncate, apex obtusely rounded and cuspidate; Stipules persistent, triangular, 6-10(-15) mm; petioles and rachis with 2 longitudinal ribs and narrow wings; petiolar glands absent; petiolules very short or leaflets sessile; leaflets 6-12(-20) pairs, (2-3 mm) caduceous bracts (1-2 x 2-3 cm), close in the dark, dense flowers (20 x 50 by 3 x 4 cm). Inflorescence yellow, racemes axillary, dense, many-flowered, or sometimes several racemes forming a terminal panicle, 10-50 cm; Peduncles 7-14 cm; Bracts caducous strobilaceous, oblong to broadly ovate, 2-3 x 1-2 cm, at first enveloping flowers. Zygomorphic flowers ca. 2.5 cm diam. Sepals orange-yellow, oblong, unequal. Petals bright yellow, tinged with conspicuous purple veins, ovate-orbicular, 16-24 x 10-15 mm, shortly clawed. Stamens 10, fertile stamens 7, opening with apical pores, lower 2 with stout

filaments *ca.* 4 mm and larger anthers, 4 with filaments *ca.* 2 mm and smaller anthers, reduced stamens 3 or 4. The ovary is puberulent and sessile; ovules many. Legume-winged, sharply tetragonal, 10-20 x 1.5-2 cm, glabrous, with a broad, membranous wing down the middle of each valve; wings 4-8 mm wide, papery, crenulate. Fruit shaped like a straight pod is up to 10 to 16 x 1.5 cm tetragonal pod, thick, flattened wings, brown when ripe with many diamond-shaped brown seeds. It is propagated by seeds and dispersed to about 1500 m above sea level. Its' seeds are distributed by water or animals.

Specimen examined: Sarawak, Serian Division, Kpg Apungan, *Hidir Marzuki s.n.*

(Herbarium Universiti Malaysia Sarawak)

Part used: Barks, roots, leaves, flowers, fruits and seeds.

Traditional use and preparation: The bark is used to treat skin diseases, parasitic diseases, scabies and eczema. The juice is extracted from the bark mixed with other ingredients (virgin coconut oil) and applied to the infected area. The leaves are crushed and mixed with coconut oil rubbed on the affected area two or three times a day and prepared fresh daily. Root fermentation is used in the treatment of diarrhoea, tympanites, uterus problems and filaria worm expulsion. It is also applied externally to treat sores and skin fungi. The leaves, flowers and fruit are mixed in an infusion to treat stomach problems. The seed is laxative and anthelmintic. It is cooked and used as a remedy for intestinal worms.

Notes: This plant species is widely used as a traditional medicine in many countries, particularly valued for its purgative effect and its effective treatment of several skin conditions, including ringworm and scabies (Boy et al. 2018). Preliminary screening of bioactive compounds for this study has detected phenol, quinine and emodin.

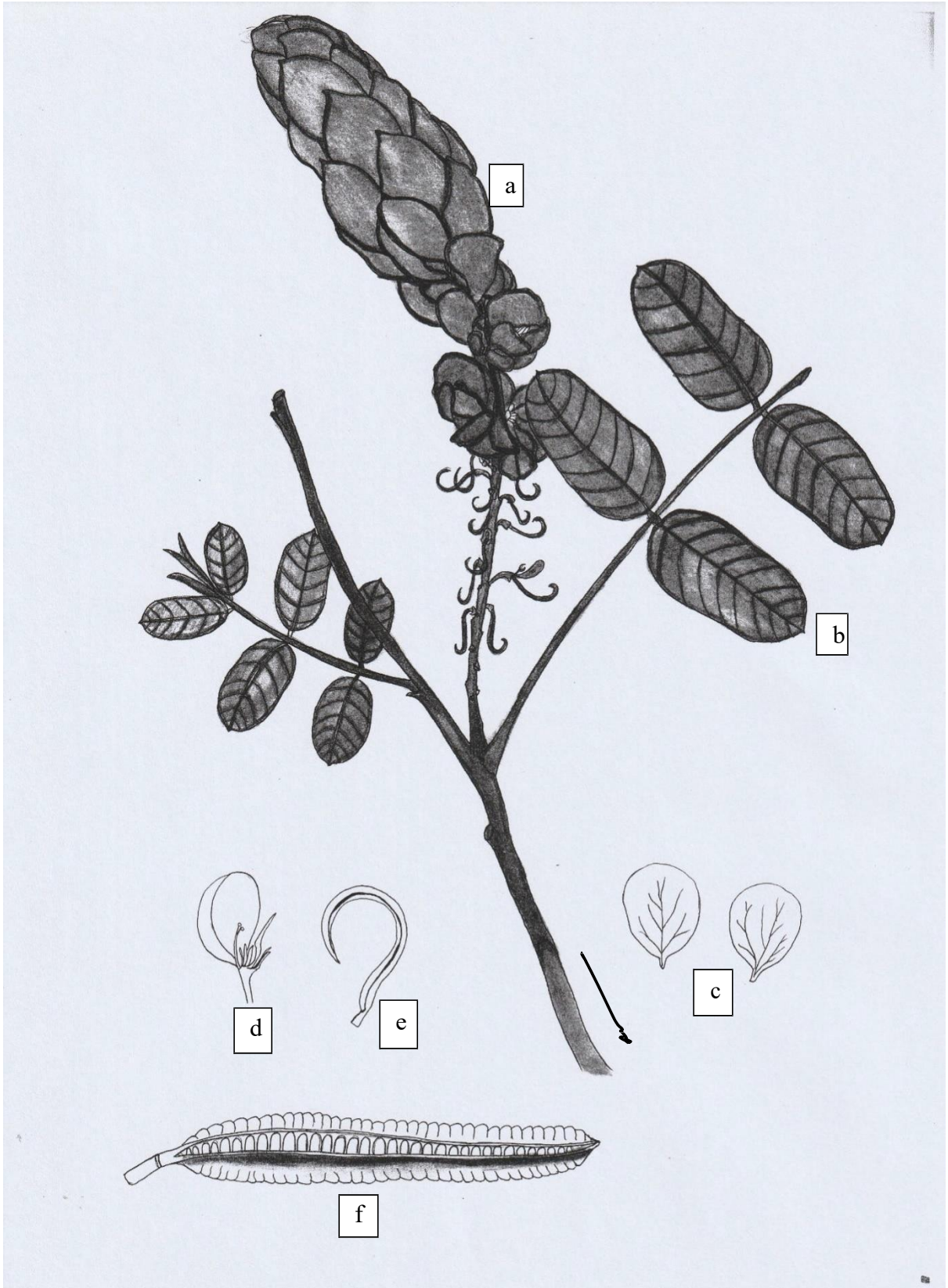


Figure 4.28: *Senna alata* (L.) Roxb. a). flowers, b). leaf, c). petal, d). stamens, f). legume-winged and g). pod



Figure 4.29: *Senna alata* L. (inflorescence)

***Vitex pinnata* L.**

Family: Lamiaceae

Vernacular name: Meruat (Bid. Bukar-Sadong), Leban (Ib.), Bunyak Laban (Mal.), Halban (Mal.), Gulimpapa (Indonesia); Leban Buas (Ib.)

Synonym: *Pistaciovitex pinnata* (L.) Kuntze; *Vitex buddingii* Moldenke; *V. digitata* Wight ex. Steud.; *V. inaequifolia* Turcz.; *V. sebesiae* H.J. Lam ex Van Leeuwen; *V. velutina* Koord.; *Wallrothia articulata* Roth.

Distribution: Indo-Malaysia region (Borneo), India, Sri Lanka, the Philippines and Cambodia.

Description: Small to medium-sized tree, 1–15 m tall (rarely more than 25 m), 10–50 cm diam., Bark smooth to flaky, usually fluted, sometimes fissured, yellowish grey to light brown, inner bark pale yellow, become green on exposure, sapwood soft yellow to brown. Leaf compound, usually with 3 leaflets (sometimes with 5), central leaflet elliptic, 7.5–22 x 3–8.5 cm, side leaflets are smaller; base rounded to slightly wedge-shaped, apex acuminate, margin entire. Inflorescence terminal, in clusters, flowers are cream, off-white and purplish. Fruits are smooth, glossy, greenish turned to purplish black on maturity.

Specimen examined: Sarawak, Serian Division, Kpg Sorak Sampung, Anna s.n. (Herbarium Universiti Malaysia Sarawak).

Part used: Bark and leaves.

Traditional use and preparation: Decoction of bark is used to treat stomach-ache, and the leaves are prepared as poultice to treat fever. The leaves were heated and pasted on the stomach, to relieve pubic pain.

Notes: Usually found in secondary forests, on riverbanks and along roads, including in marginal of the forests. The fruits are eaten by birds.



Figure 4.30: *Vitex pinnata* L. A: leaves and inflorescence, B: fruits

***Eusideroxylon zwageri* Teijsm. & Binn.**

Family: Lauraceae

Vernacular name: Tahas (Bid. Bukar-Sadong); Belian (Mal.)

Synonym: *Eusideroxylon borneense* Fern.-Vill. *Distribution:* Endemic to Borneo and Sumatra.

Description: Medium to big tree, up to 50 m tall, and 220 cm in diam., bole straight with buttresses, bark grey-brown and flakes off in small pieces. Leaves elliptic to ovate, 10–20 x 5–12 cm, leathery, base rounded, apex acute, margin entire, upper surface smooth, shiny, lower surface with minute hairs, and raised venations. Flowers are small, greenish, yellow or purplish, drooping clusters at the axillary, and have a pleasant fragrance. Fruits are elliptic or oval shaped, drupe, turned shiny black when mature. Each fruit contain one large seed with a hard and furrowed seed coat.

Specimen examined: Sarawak, Serian Division, Kpg Sg. Paon, Anna s.n. (Herbarium Universiti Malaysia Sarawak).

Part used: Fruits

Traditional use and preparation: The fruits have been used medicinally as a treatment against swellings. The boles are used for constructions.

Notes: Grows in lowland forests and secondary forests up to 500 m altitudes (including in the swampy areas). Endemic to Borneo and Sumatra, and become rare in natural habitat due to habitat degradation, habitat loss and over-harvested.

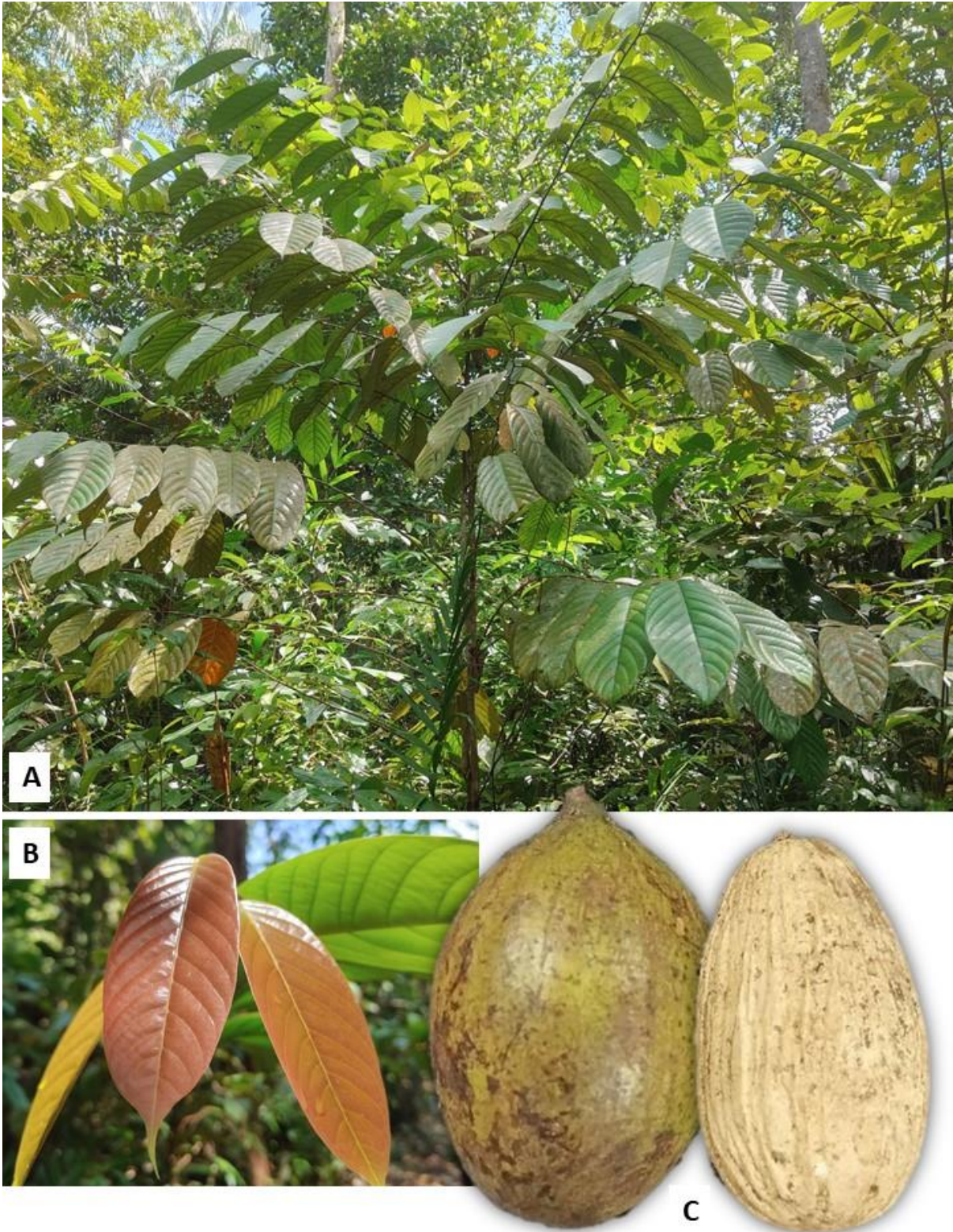


Figure 4.31: *Eusideroxylon zwageri* Teijsm. & Binn. A: whole plant, B: young leaves, C: fruit and seed

***Lindernia diffusa* (L.) Wettst.**

Family: Linderniaceae

Vernacular name: Uduh kalak nasi (Bid. Bau); Rumput mata pelanduk (Mal.)

Synonym: *Bonnaya organifolia* Spreng; *Gratiola organifolia* Vahl.; *Pyxdaria diffusa* (L.) Kuntze; *Sibthorpia americana* Sesse & Moc.; *S. diffusa* Sesse & Moc. ex C. Nelson; *Vandellia diffusa* L.

Distribution and Ecology: Widespread in South America, the Caribbean, west tropical Africa and Madagascar. Also common elsewhere in tropical countries, as non-native weeds. Frequently found at damp sites, moist thickets or fields, sometimes in waste ground, dwellings along streams or near waterbodies, at elevations up to 1000 m above sea level.

Description: Annual, much-branched, prostrate, 2.5-5 cm long; stems up to 20 cm long, often rooting at lower nodes, quadrangular, short, white, patent, hirsute throughout, mainly on angles. Leaves broadly ovate to subcircular, 12-19 (-25) mm x 9-15(-19) mm, apex obtuse, margins finely crenate-serrate, base rounded to broadly cuneate, glabrous above, shortly spreading hirsute on major veins beneath, somewhat densely ciliolate, 3-veined from the base with midvein once or twice pinnately branched. Petioles 1-2 mm long, densely hairy. Flowers solitary in axils mostly of upper leaves; pedicels 2-3.5 mm long in flower, extending to 4-8 mm in fruit, stout, densely hairy, ascending in fruit, never reflexed. Calyx prominently 5-ribbed, 3.5-4.5 mm long, patent white-hirsute; lobes narrowly lanceolate to subulate, 1.8-2(-2.5) mm long, acuminate, ciliate; lobes accrescent to 3-5mm long, widely spreading and distorted after dehiscence of the capsule. Corolla white or cream, 5-6 mm long, tube \pm 4.5 mm long; upper lip shallowly emarginate or minutely irregularly toothed; lower lip somewhat deeply 3-lobed with median lobe rounded to sub truncate, minutely dentate.

Stamens 4, fertile; anterior filaments geniculate, gibbous at the base below geniculation, minutely yellow-glandular. Capsule oblong-ellipsoid, 7–7.5(–12) x 2–3.5 mm.

Specimen examined: Sarawak, Serian Division, Kpg Murud Mawang, *Hidir Marzuki s.n.* (Herbarium Universiti Malaysia Sarawak).

Part Used: whole plant and leaves.

Notes: Previously the genus *Lindernia* was placed under the family Scrophulariaceae, and based on molecular studies, now segregated under its own family, Linderniaceae (Fischer et al. 2013). This species is widely distributed in the tropics, and according to the IUCN Red List, this species is considered as Least Concern. Preliminary screening of bioactive compounds for this study has detected phenol and emodin.

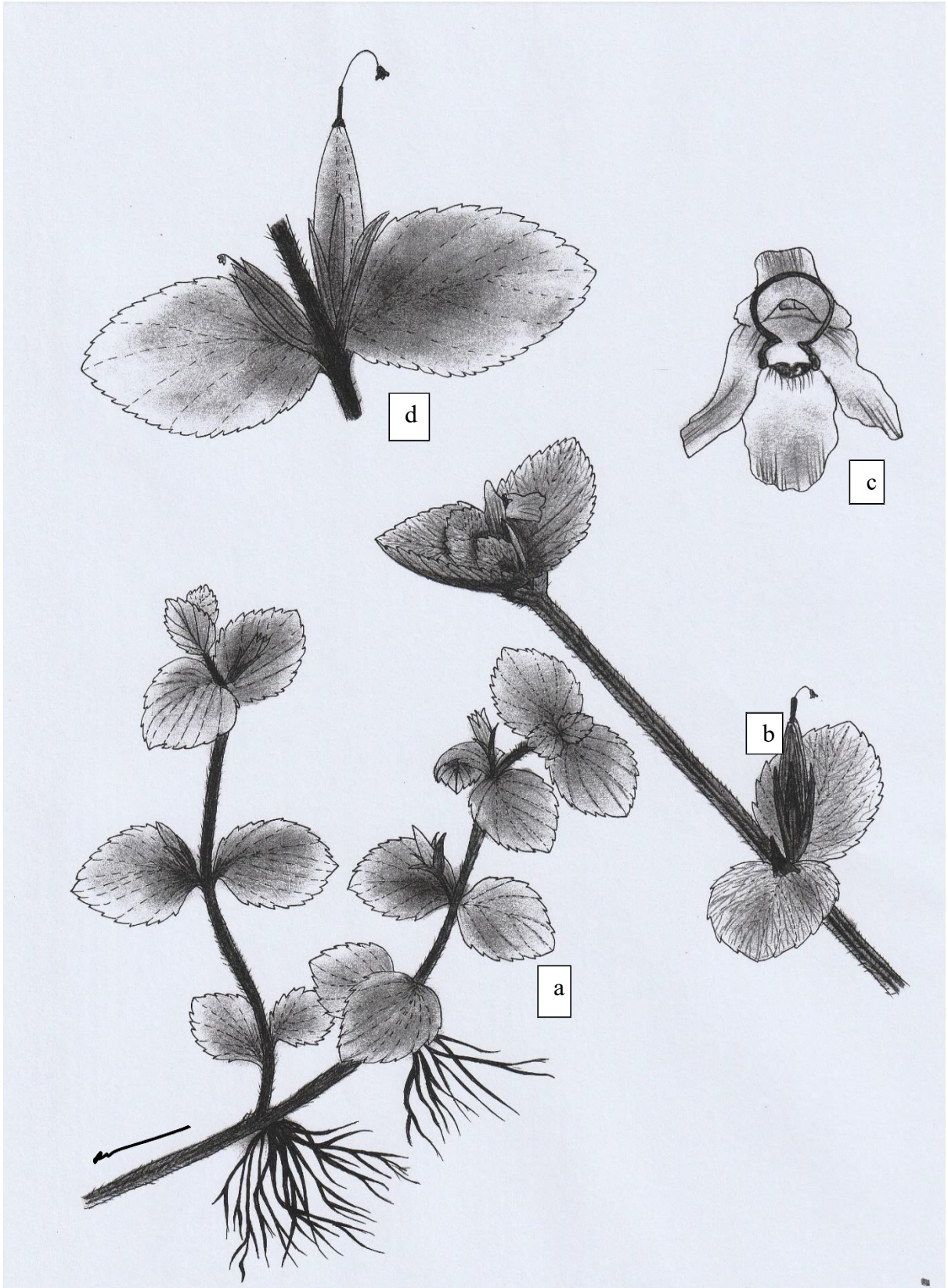


Figure 4.32: *Lindernia diffusa* (L.) Wettst. a). leaf, b). flower, c). close up of flower and d). close up leaf with flower



Figure 4.33: *Lindernia diffusa* (L.) Wettst. A): creeping plants, B): close-up flower

***Durio zibethinus* L.**

Family: Malvaceae

Vernacular name: Dihan (Bid. Bukar-Sadong), Durian (Mal.)

Synonym: *Durio acuminatissimus* Merr.

Distribution: Commonly cultivated throughout Southeast Asia countries.

Description: Medium to big tree, up to 40–50 m tall, 120 cm in diam. (or more), bole straight with buttresses, bark rough, and conical crown. Leaves are oblong, rounded at the base, acute or acuminate apex, margin entire. Flowers yellowish green along the older branches, fragrance. Fruits are spherical, with hard, spiny shell, 15 – 25 cm in diam. (sometimes smaller, or larger), 5-compartments fill with cream or golden yellow or yellowish pulp that contains one to five chesnut-sized seeds. The fruit has a strong, distinctive odour.

Specimen examined: Sarawak, Serian Division, Kpg Mang Besi, Anna s.n. (Herbarium Universiti Malaysia Sarawak).

Part used: Fruits, flowers and seeds, and wood.

Traditional use and preparation: Flowers and immatured fruits are cooked as vegetable. The fruits are used as an aphrodisiac.

Notes: One of the most commonly cultivated fruit tree in the Serian Division.

***Hibiscus rosa-sinensis* L.**

Family: Malvaceae

Vernacular name: Bunga raya, Chinese rose

Distribution: Widely cultivated throughout the world.

Description: Shrub to small tree, erect, bushy-liked shrub with many branches, 1 – 4 m in height. The leaves are ovate, 4 – 12 x 3 – 5 cm, with coarsely toothed margins. The flowers are solitary, very large, about 6 – 10 cm long, and reach 10 cm in diam. (in few varieties). The calyx is green, 2 cm long, with ovate lobes. Petals are varying, red, orange, yellow or rose- white, obovate, rounded and imbricate. The staminal tube is slender and longer than the corolla.

Specimen examined: Sarawak, Serian Division, Kpg Mang Besi, Anna s.n. (Herbarium Universiti Malaysia Sarawak).

Part used: Leaves and flowers

Traditional use and preparation: The leaves are boiled (sometimes mixed with other plants) and used as a bath to relieve body pain. The decoction of dried leaves is used for infection of the urinary tract. Flowers buds, beaten into a paste, are applied as poultice to boils, cancerous swellings and mumps. The fresh leaves were crushed and put forehead to relieve headaches.

Notes: Rasadah et al. (2010) reported that *Hibiscus rosa-sinensis* leaves contain abundant calcium oxalate, peroxidase, fats and proteins.

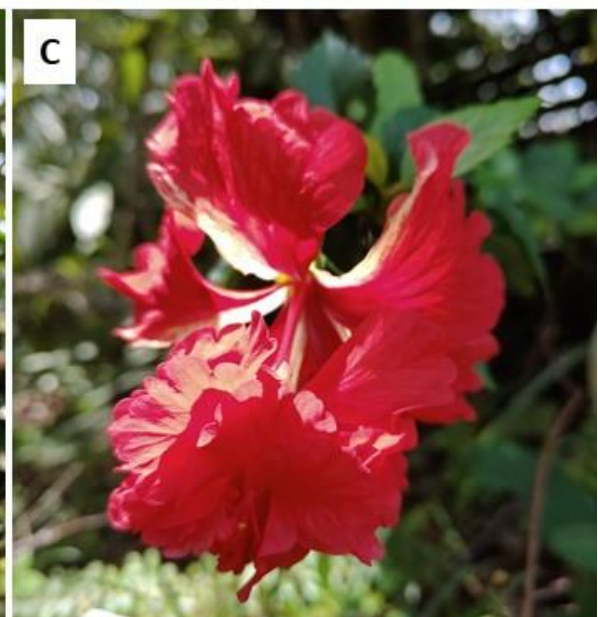


Figure 4.34: *Hibiscus rosa-sinensis* L. A). red form, B) white-red form c). multiple petals form

***Averrhoa bilimbi* L.**

Family: Oxalidaceae

Vernacular name: Girinang (Bid. Ser.); Belimbing buluh, Bling, Biling-biling, Belimbing asam (Mal.); Bilimbi, Cucumber tree, Sorrel tree (Eng.); Belimbing besu, Balimbing, Blimbing wuluh (Indon.); Kamias (Filipino); Talingpling (Thai.)

Synonym: *Averrhoa abtusangulata* Stokes; *A. obtusangula* Stokes

Distribution and Ecology: Origin from Moluccas, Indonesia. Now found cultivated throughout the Southeast Asia countries, India and South America. Planted as ornamental or for medicinal use. Growing best in rich and well-drained soils or near to the streams or rivers.

Description: The tree is attractive, long-lived, reaches 5-10 m in height; has a short trunk soon dividing into several upright branches. The leaves, very similar to those of the Otaheite gooseberry and mainly clustered at the branch tips, are alternate, imparipinnate; 30-60 cm long, with 11 to 37 alternate or sub-opposite leaflets, ovate or oblong, with a rounded base and pointed tip; downy; medium-green on the upper surface, pale on the underside; 2-10 cm long, 1.2-1.25 cm wide. Small, fragrant, 5-petalled flowers, yellowish or purplish marked with dark-purple, are borne in small, hairy panicles emerging directly from the trunk and oldest, thickest branches and some twigs, as do the clusters of curious fruits. The bilimbi is ellipsoid, obovoid or nearly cylindrical, faintly 5-sided, 4-10 cm long; capped by a thin, star-shaped calyx at the stem-end and tipped with 5 hair-like floral remnants at the apex. The fruit is crisp when unripe, turns from bright green to yellowish-green, ivory or nearly white when ripe and falls to the ground. The outer skin is glossy, very thin, soft and tender, and the flesh is green, jelly-like, juicy and extremely acidic. There may be a few (perhaps 6 or 7) flattened, disc-like seeds about 6 mm wide, smooth and brown

Specimen examined: Sarawak, Serian Division, Kpg Sebemban, *Hidir Marzuki s.n.*

(Herbarium Universiti Malaysia Sarawak)

Part used: Leaves, flowers and fruits

Traditional use and preparation: The leaves serve as a paste on itches, leaves sock in water and for baths, swelling, rheumatism, skin eruptions and used for bites of venomous creatures. Also applied to boils and used to treat rheumatism, fever diabetes and whooping cough. A leaf mixture is used as an after-birth tonic, while the flower infusion is used for thrush, cold and cough. The leaves are sock in water and for baths to treat jaundice. Malay people use fermented or fresh bilimbi leaves to treat venereal diseases. The mixture of leaves and fruits is used to treat syphilis. Syrup made from the fruit is used to treat inflammatory conditions.

Notes: A commonly planted plant in the orchards or kampung gardens, especially for fruit or as a cash crop. Now become a popular plant for the stingless bees' honey industry. Preliminary screening of bioactive compounds for this study has detected phenol and emodin.

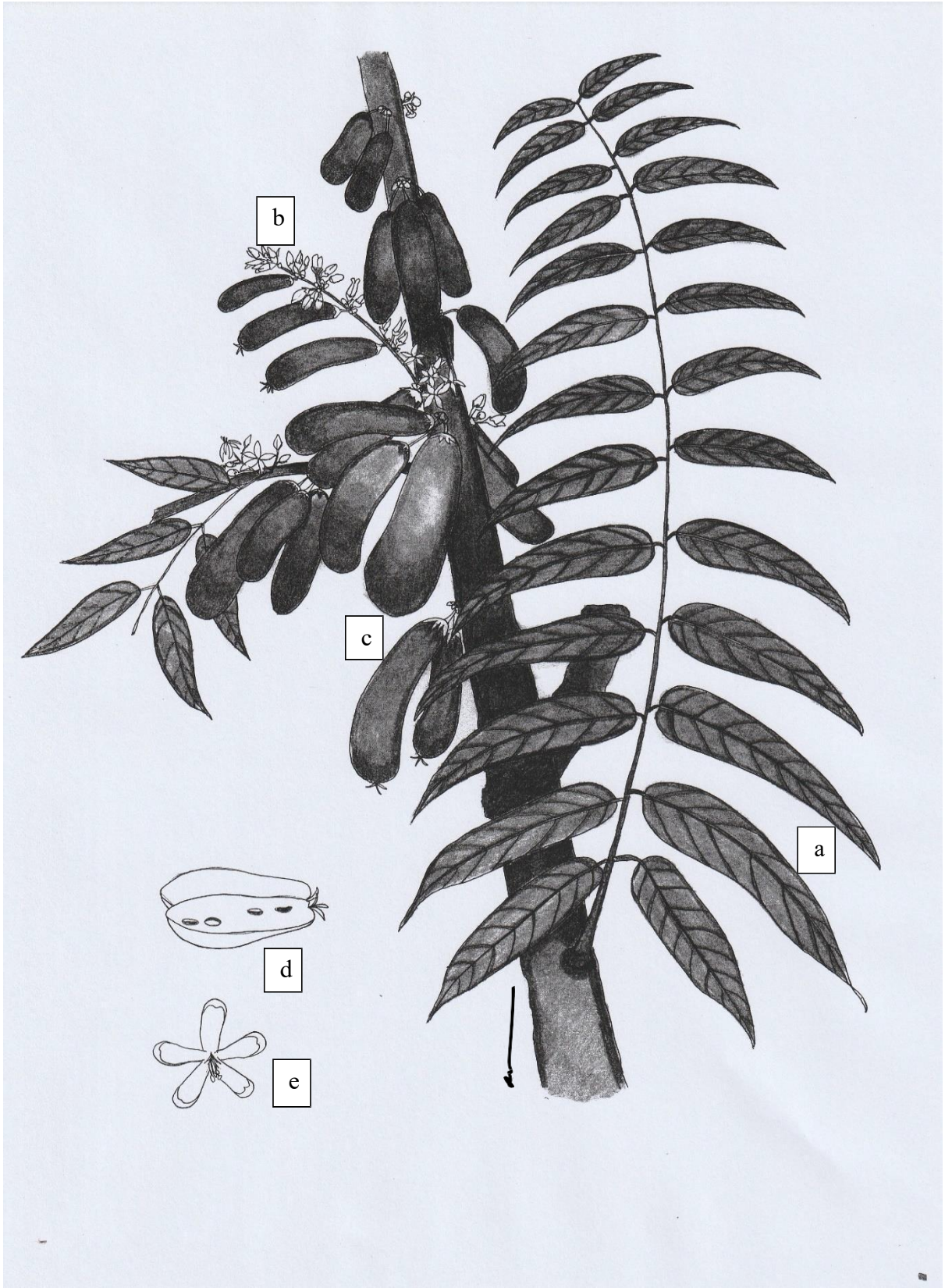


Figure 4.35: *Avorrhoea bilimbi* L. a). leaf, b) flowers, c). fruit, d). cross section of fruit and e). close up of flowers

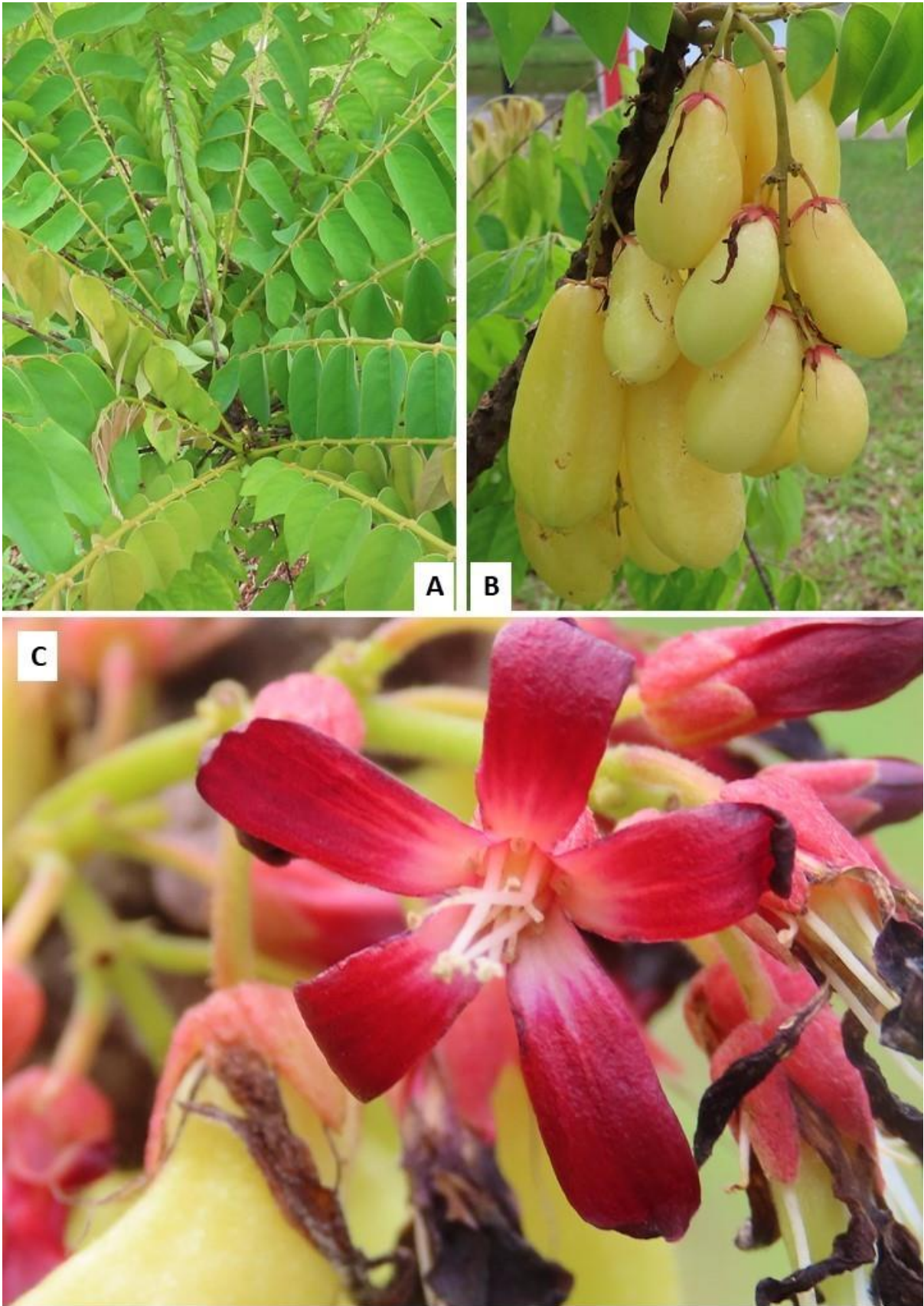


Figure 4.36: *Avorrhoea bilimbi* L. A: leaves, B: fruits, C: close-up flower

***Piper betle* L.**

Family: Piperaceae

Vernacular name: Baid (Bid. Ser.); Sirih (Mal.); Betle vine (Eng.); Vetrilai (Ind.); Ju Jiang (Chi.)

Synonym: *Artanthe hexagyna* Miq.; *Betela mastica* Raf.; *Chavica betle* (L.) Miq.; *C. blumei* Miq.; *C. canaliculata* (Opiz) C. Presl; *C. chuvya* Miq.; *C. densa* Miq.; *C. siriboa* (L.) Miq.; *Cubeba melamiri* Miq., *C. seriboa* Miq.; *Macropiper potamogetonifolium* (Opiz) Miq.; *Piper anisodorum* Naves ex Fern.-Vill.; *P. anisodorum* Blanco; *P. bathicarpum* C. DC.; *P. betel* Blanco; *P. bidentatum* Stokes; *P. blancoi* Merr.; *P. blumei* (Miq.) Backer; *P. canaliculatum* Opiz; *P. carnistilum* C. DC.; *P. densum* Blume; *P. fenixii* C. DC.; *P. macgregorii* C. DC.; *P. malamiri* Blume; *P. malamiris* L.; *P. malarayatense* C. DC.; *P. marianum* Opiz; *P. philippinense* C. DC.; *P. pinguispicum* C. DC. & Koord.; *P. potamogetonifolium* Opiz; *P. puberulinodum* C. DC.; *P. rubroglandulosum* Chaveer. & Mokkaumul; *P. saururus* Burm.; *P. siriboa* L.; *Piperi betlum* (L.) St.-Lag.

Distribution and Ecology: Southeast Asia

Description: Perennial climber, vine and liana, 3 to 4.5 m high. A semi-woody branching vine with a sprawling or climbing growth habit. Stems round, orangish to reddish. Petiole like the stem reddish, 2-4 cm long. Leaves light green to bright green, ovate or rounded ovate, 8-18 x 6-10 cm, apex acuminate, glossy, simple or unifoliate, entire, petiolate, deeply veined, pinnate and hairless, base cordate or subcordate and mostly asymmetric at the base. They are heart-shaped with an entire leaf margin. Inflorescence white catkins developed on the node, 2 cm long, spike, cluster, axillary, erect or pendulous, small, without sepal and petal; stamens 2; stigmas 4-5; bracts rounded to obovate. Fruits fleshy, sessile, green, globose to ellipsoidal

Specimen examined: Sarawak, Serian Division, Kpg Plaman Baki, *Hidir Marzuki s.n.*
(Herbarium Universiti Malaysia Sarawak)

Part used: Leaves, stems and roots

Traditional use and preparation: Leaf preparations and the leaf sap are applied to wounds, ulcers, boils and bruises. Leaves decoction paste on forehead to relieve fever or leaves sock with *Allium cepa* for bathing also can relieve fever. Heated leaves are applied as a poultice on the chest against cough and asthma, on the breasts to stop milk secretion, and on the abdomen to relieve constipation. The leaves are also used to treat nosebleeds, ulcerated noses, gums and mucous membranes while the extract from the leaves is applied for wounds in the ears and as an infusion for the eye. The leaves are crushed with an areca nut applied to the stomach to treat a bloated stomach. A decoction of the leaves is used to bathe a woman after childbirth or is drunk to lessen an unpleasant body odour.

Specimen examined/observed: Plant observed in the field during the surveys at Kpg Mang Besi, Kpg Murud Mawang, Kpg Ampungan, Kpg Tebakang Dayak, Kpg Sebemban, Kpg Plaman Baki, Kpg Rayang and Kpg Kijang Sain.

Part used: Whole plant, and leaves.

Traditional use and preparation: Leaves were crushed and mixed with shallot, becoming a massage element to treat fever. The young leaf was crushed and pasted on the forehead, also to treat fever. A respondent from Kpg Tepoi informed that the crushed leaves were pasted on a wound.

Notes: Important chemical constituents are the phenols eugenol, chavicol, methyl chavicol (estragol) and chavibetol. *Baid* is one of many common medicinal plants planted in orchards or near houses in Bidayuh villages. Betel leaf farming is one of the important income-based for local farmers in Bangladesh, Sri Lanka and India.

***Piper porphyrophyllum* N.E. Br.**

Family: Piperaceae

Vernacular name: Sirih hutan (Bid., Mal.); Kerakap Harimau (Mal. – Negeri Sembilan); Sireh Harimau, Sireh Rimau, Sirih Rimau (Mal.), Sirih Merah (Mal. – Kelantan).

Synonym: *Piper leptonema* Hook. f.

Distribution and Ecology: native to Peninsular Thailand, Peninsular Malaysia, Sumatra and Borneo. Usually in shady areas in many types of forests such as limestone, mixed dipterocarp forest and swampy areas. Also common in rubber plantations.

Description: Distinguished by its coloured spots or bands in the young leaves, which are similar to *P. ornatum*, and become pale green when mature. In addition, the floral bracts are oblong during flowering, becoming spatulate in fruit and the catkin-like inflorescences, and sessile fruits, are sparse on the rachis. The inflorescence is sessile flowers along the axis, spike. Leaves, reticulate

Specimen examined: Sarawak, Serian Division, Kpg Tian Mawang, *Hidir Marzuki s.n.* (Herbarium Universiti Malaysia Sarawak)

Part used: Whole plant and leaves.

Traditional use and preparation: The leaves are rubbed with coconut oil and pasted on the stomach for stomach aches in children. The crushed leaves are mixed with coconut oil to treat skin diseases.

Notes: Climbing vines in the forests with a very decorative leaf venation, potential for ornamental. This species is one of the common species in secondary forests, rubber plantations or foothills of limestone hills. Preliminary screening of bioactive compounds for this study has detected phenol, thymol and emodin.



Figure 4.37: *Piper betle* L. top). climbing and thicketing of plant, bottom left). upper surface of leaf, bottom right). lower surface of leaf

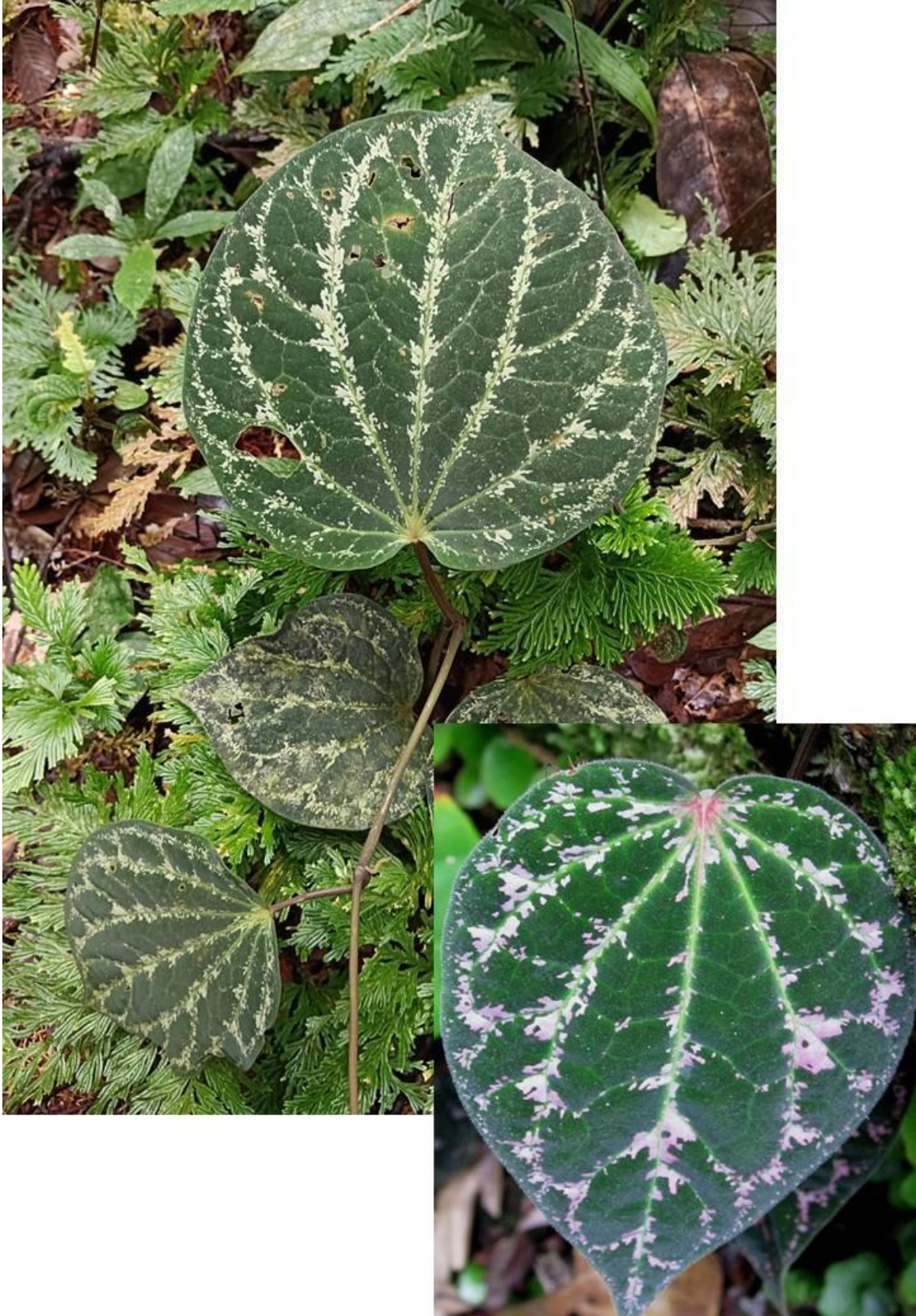


Figure 4.38: *Piper porphyphyllum* N.E. Br. part of creeping plant). insert). Close-up of the upper surface leaf

***Dendrocalamus asper* (Schult.) Baker**

Family: Poaceae

Vernacular name: Buru (Bid. Bukar-Sadong), Tubok manis (Ib.), Buluh betong (Mal.), Giant Bamboo (Eng.)

Synonym: *Dendrocalamus flagellifer* Munro

Distribution: Native to Andaman Island, Bangladesh, China, Indo-China, Thailand, Sumatra, the Philippines and Borneo.

Description: Clumping bamboo, large woody culms, up to 25 m tall, 8–20 cm in diam., relatively thick walls, 10–20 mm diam., branches grow from nodes on the stem, which are spaced *ca.* 50 cm apart, pale green, and covered with short brown hairs, cluster with 1 large central dominant branch, that usually occur from 9th node and up. The lower culms with an aerial root from the nodes. Leaves blades are lance-shaped, 15–30 cm x 10–25 mm. Flowers and fruits are not seen.

Specimen examined: Serian Division, Kpg Ranchan, *Hidir Marzuki s.n.* (Herbarium Universiti Malaysia Sarawak)

Part used: Culm and young shoot.

Traditional use and preparation: Young shoots (*Rebung*) were sliced and cooked as vegetables. The mature culms were used for construction.

Notes: One of many potential local bamboo species for plantation elements.



Figure 4.39: *Dendrocalamus asper* (Schult.) Baker. A). leaf sheath, B: young shoot (*Rebung*), C: branching type

Oryza sativa* L. var. *glutinosa

Family: Poaceae

Vernacular name: Bare purut (Bid.); Padi pulut (Mal.)

Synonym: *Oryza glutinosa* Lour.; *O. sativa* var. *affinis* Körn.; *O. sativa* var. *erythroceros* Körn.; *O. sativa* var. *flavoacies* Kara-Murza ex Zhuk.; *O. sativa* ssp. *indica* Kato.; *O. sativa* cv. *italica* Alef.; *O. sativa* ssp. *japonica* auct.; *O. sativa* var. *japonica* auct.; *O. sativa* var. *melanacra* Körn.; *O. sativa* var. *suberythroceros* Kanevsk; *O. sativa* var. *vulgaris* Körn.; *O. sativa* var. *zeravschanica* Brches ex Katzaroff, *nom. nud.*

Distribution and Ecology: Cultivated in many countries in Southeast Asia. On well drainage soils.

Description: Tufted grass, 0.5–1.8 m high (sometimes taller up to 3–5 m tall), usually with 4–5 tillers, culm erect, rooting at lower submerged nodes. Leaf-sheaths slightly inflated below, upper sheaths tight, glabrous, auricles falcate, ciliate. Leaves linear, 20–50 cm x 5–15 mm, glabrous, smooth or scabrid on both sides, margin scabrid, apex acuminate; ligule 10–30 mm. Inflorescence is a panicle, loosely contracted, up to 50 cm long, nodding at maturity, branches 1–3 at lower node, bearing 50 to 500 spikelets. Spikelets contain 3–flowers, 2 of which are sterile, oblong to oblong-lanceolate, 6–12 mm length, 2–3 times width, persistent; sterile lemmas lanceolate, 1.5–5 mm, apex acuminate; fertile lemma papillose, spinulose, apex acuminate; awn very variable, slender to stout, up to 55 mm (sometimes longer), scaberulous, sometimes absent. Anthers 1–3 mm. Caryopsis is ovate or elliptic to cylindrical, 5–6 mm, whitish yellow or dark purplish blackish.

Specimen examined: Sarawak, Serian Division, Kpg Mang Besi, *Hidir Marzuki s.n.*

(Herbarium Universiti Malaysia Sarawak)

Part used: Fruits/grains

Traditional use and preparation: The fruits or grains of *Bare pulut* were soaked in water and used as a bath to treat scabies.

Notes: Cultivated for grains. Preliminary screening of bioactive compounds for this study has detected phenol and emodin.



Figure 4.40: *Oryza glutinosa* L. var. *glutinosa*. a). leaf, b). grain, c). leaf-sheaths, d). close up of grain, e). spike and f). cross section of spike

***Phyllanthus niruri* L.**

Family: Phyllanthaceae

Vernacular name: Uduh injes (Bid. Bukar-Sadong), Dukong anak (Mal.), Gale of the wind (Eng.), Stonebreaker plant (Eng.)

Synonym: *Diasperus niruri* (L.) Kuntze, *Niruris annua* Raf., *Nymphanthus niruri* (L.) Lour., *Phyllanthus lathyroides* Britton & Wilson, *P. niruri* L. var. *genuinus* Muell.-Arg., *P. nirurui* L., *P. niruri* L. ssp. *lathyroides* (Kunth) G.L. Webster

Distribution: Widely distributed in tropic

Description: Small herb, about 20–50 cm tall (sometimes up to 70 cm), stem light green, smooth and cylindrical, branches are slightly angular. Leaves simple, alternate, and distichous, oblong shape, apex rounded, asymmetrical base, margin entire, 10–15 x 2–5 mm. Flowers are small, greenish, pale green or yellow, and often flushed with red. Fruit tiny, globose, capsules containing seeds, smooth, green.

Specimen examined: Sarawak, Serian Division, Kpg Tepoi, Hidir *Marzuki s.n.* (Herbarium Universiti Malaysia Sarawak)

Part used: Whole plant

Traditional use and preparation: The plants are boiled, and drunk to treat high fever. *Notes:* Some studies suggest that *Phyllanthus niruri* may have anti-inflammatory, anti-ulcer, and anti-diabetic properties.



Figure 4.41: *Phyllanthus niruri* L. A: whole plant, B: flowers, C: immature fruits, D: ripe fruit

***Morinda citrifolia* L.**

Family: Rubiaceae

Vernacular name: Kudu (Bid. Ser.); Mengkudu, Mengkudu besar (Mal.); Great Morinda, Indian Mulberry, Noni, Beach Mulberry, Cheese fruit, Brimstone tree (Eng.)

Synonym: *Belicea hoffmannioides* Lundell.; *Morinda aspera* Wight & Arn.; *M. asperula* Standl.; *M. bracteata* Roxb.; *M. chachuca* Buch.-Ham.; *M. elliptica* (Hook. f.) Ridl.; *M. ligulata* Blanco.; *M. litoralis* Blanco.; *M. macrophylla* Desf.; *M. mudia* Buch.-Ham.; *M. multiflora* Roxb.; *M. nodosa* Buch.-Ham.; *M. quadrangularis* G. Don.; *M. stenophylla* Spreng.; *M. teysmanniana* Miq.; *M. tomentosa* B. Heyne ex Roth.; *M. zollingeriana* Miq.; *Platanocephalus orientalis* Crantz.; *Samama citrifolia* (L.) Kuntze.; *Sarcocephalus leichhardtii* F. Muell.

Distribution and Ecology: Native to India, Indo-China, Southeast Asia, Australia and the Pacific Islands. Usually in shady forests or on open rocky or sandy shores, on wet areas near streams or rivers.

Description: Small to medium-sized tree (sometimes large evergreen), up to 3–10 m tall, c. 15 cm in diam. (sometimes up to 20 cm diam.); bark smooth, slightly rough and grey to light brown, sapwood yellow-brown. Twigs angular (four-angled). Stipules connate or distinct, 10–12 mm long, apex entire or 2-3 lobed. Leaves opposite, glossy, blades membraneous; blades elliptic to elliptic-ovate, 5–18 (- 45 cm) x 10–15 cm (-25 cm), apex acute, margin entire, leaf base cuneate or broadly acute; petioles stout. Flowers perfect, 75–90 in ovoid to globose heads, fragrant; peduncles 10–30 mm long, calyx truncated rim. Corolla white, five-lobed, with the tube greenish-white, 7–9 mm long, lobes oblong-deltate, ca. 7 mm long; stamens 5, scarcely exerted, style ca. 15 mm long. Fruit syncarp, yellowish-white and

fleshy, 5–14 cm long, *ca.* 3–7.5 cm in diam., soft and fetid when ripe. Seeds brown, *ca.* 4–9 mm long, with distinct air chamber.

Specimen examined: Sarawak, Serian Division, Kpg Mang Besi, *Hidir Marzuki s.n.*

(Herbarium Universiti Malaysia Sarawak)

Part used: Leaves, fruits and stems.

Traditional use and preparation: The leaves are slowly heated on fire until they turn light brown, rubbed with coconut oil and then pasted on swollen parts. The mature or ripe fruits blend with young leaves and rhizomes to make juice as a tonic drink.

Notes: The plant has a rooting habit similar to citrus and coffee, with an extensive lateral root system and a deep taproot. Also used as a spiritual plant by the respondent of Kpg Mang Besi to remove evil charm in the body. Preliminary screening of bioactive compounds for this study has detected four targeted biocompound; carvocrol, phenol, thymol and emodin.

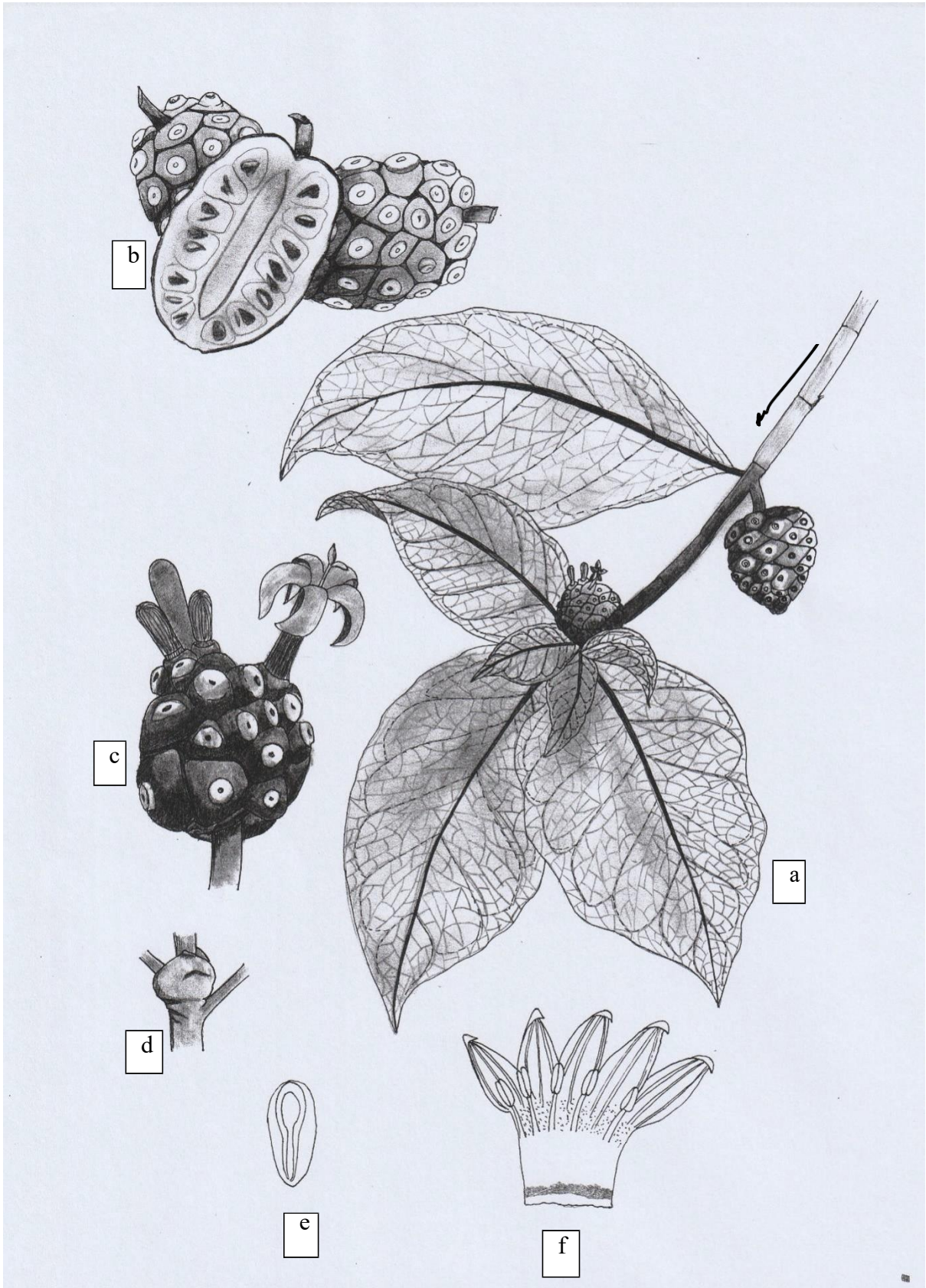


Figure 4.42: *Morinda citrifolia* L. a). leaf, b). cross section of fruit, c). globose heads fruit, d). tube, e). seed and f). stamen



Figure 4.43: *Morinda citrifolia* L. A: whole plant, B: leaves, flower and fruits, C: flowers, D: ripe fruit

***Citrus aurantifolia* (Christm.) Swingle**

Family: Rutaceae

Vernacular name: Rimu nipis (Bid.); Limau nipis (Mal.)

Synonym: *Citrus acida* Roxb.; *C. hystrix* ssp. *acida* (Roxb.) Engl.; *C. lima* Lunan; *C. limetta* var. *aromatica* Wester; *C. medica* var. *acida* (Roxb.) Hook. f.; *Limonia acidissima* Christm.

Distribution: Cultivated.

Description and Ecology: Small to medium-sized tree, densely and irregularly branched, ca. 5 m tall. Twigs and stems armed with short, stiff, sharp spines. Leaves alternate, elliptic to oblong-ovate, 4–8 x 2–5 cm, apex acuminate, margin crenulated, base cuneate; petioles narrowly winged. Inflorescences short axillary racemes, 1–7 flowers (sometimes up to 10 flowers); flowers small, white in bud; calyx cup-shaped, 4–6-lobed; petals 4–6, 8–12 mm long; stamens 20–25(–34), ovary 9–12(–15)-celled, style abruptly distinct. Fruit globose to ovoid berry, 3–6 cm in diameter, sometimes with apical papillae, greenish-yellow; peel very thin, very densely glandular; segments with yellow-green pulp-vesicles, very acid, juicy and fragrant. Seeds are small, plump, ovoid, pale, and smooth with white embryos (polyembryonic).

Specimen examined: Sarawak, Serian Division, Kpg Sebemban, 20.08.2016, *Hidir Marzuki* s.n. (Herbarium Universiti Malaysia Sarawak).

Part used: Fruits (juice).

Traditional use and preparation: The juice is obtained by squeezed fruits, mixed with camphor and rubbed on infected skin (skin disease – lymph nodes).

Notes: Key lime (*Limau nipis*) is widely used by the Malay people in their daily lives, either as food flavour or in their traditional beliefs (*bomoh*). This species originates from India and Myanmar, and is now widely cultivated in many countries of tropical and subtropical.



Figure 4.44: *Citrus aurantifolia* (Christm.) Swingle. Top left). leaves, top right). Close-up of flower, bottom). Fruits

***Physalis foetida* L.**

Family: Solanaceae

Vernacular name: Ratup (Bid.); Letup-letup (Mal.)

Synonym: *Dysosmia ciliata* (Dryand.) M. Roem.; *D. fluminensis* M. Roem.; *D. foetida* (L.) M. Roem.; *D. gossypifolia* (Desv. ex Ham.) M. Roem.; *D. hastata* (Bertol.) M. Roem.; *D. hibiscifolia* (Lam.) M. Roem.; *D. hircina* Sweet ex M. Roem. nom. illeg.; *D. nigelliflora* (Hook.) M. Roem.; *D. polyadena* (Vell.) M. Roem.; *Granadilla foetida* (L.) Gaertn.; *Passiflora baraquiniana* Lem.; *P. ciliata* Dryand.; *P. ciliata* Dryand. var. *polyadena* Griseb.; *P. ciliata* Dryand. var. *quinqueloba* Griseb.; *P. ciliata* Dryand. var. *riparia* C. Wright ex Griseb.; *P. foetida* L. f. *suberecta* Chodat & Hassl.; *P. foetida* L. f. *latifolia* Kuntze; *P. foetida* L. f. *longifolia* Kuntze; *P. foetida* L. f. *quinqueloba* (Griseb.) Mast.; *P. foetida* L. var. *acapulcensis* Killip; *P. foetida* L. var. *arizonica* Killip; *P. foetida* L. var. *balansae* Chodat; *P. foetida* L. var. *ciliata* (Dryand.) Mast.; *P. foetida* L. var. *eliasii* Killip; *P. foetida* L. var. *fluminensis* (M. Roem.) Killip; *P. foetida* L. var. *galapagensis* Killip; *P. foetida* L. var. *gardneri* Killip; *P. foetida* L. var. *glaziovii* Killip; *P. foetida* L. var. *gossypifolia* (Desv. ex Ham.) Mast.; *P. foetida* L. var. *hastata* (Bertol.) Mast.; *P. foetida* L. var. *hibiscifolia* (Lam.) Killip; *P. foetida* L. var. *hirsuta* Mast.; *P. foetida* L. var. *hirsutissima* Killip; *P. foetida* L. var. *hispida* (DC. ex Triana & Planch.) Killip; *P. foetida* L. var. *isthmia* Killip; *P. foetida* L. var. *lanuginosa* Killip; *P. foetida* L. var. *maxonii* Killip; *P. foetida* L. var. *mayarum* Killip; *P. foetida* L. var. *salvadorensis* Killip; *P. foetida* L. var. *sericea* Chodat & Hassl.; *P. foetida* L. var. *subpalmata* Killip; *P. foetida* L. var. *variegata* G. Mey.; *P. gossypifolia* Desv. ex Ham.; *P. hastata* Bertol.; *P. hibiscifolia* Lam.; *P. hibiscifolia* Lam. var. *velutina* Fenzl ex Jacq.; *P. hispida* DC. ex Triana & Planchon; *P. hirsuta* Lodd. nom. illeg.; *P. nigelliflora*

Hook.; *P. polyadena* Vell.; *P. vesicaria* L.; *P. variegata* Mill.; *Tripsilina foetida* (L.) Rafinesque.

Distribution and Ecology: Many species are growing in warm and subtropical regions across the world. The centre of species distribution is in Central America. *Physalis foetida*, is a common species in Southeast Asia, thriving well on infertile soils, degraded areas and secondary forests.

Description: Perennial fetid scrambling or climbing vine with hispid, green cylindrical stems 1.5–5 m long and axillary tendrils. Leaves simple, asymmetrically in pairs at each node, alternate, broadly ovate to cordate, 2.5–10 x 2.5–10 cm, stipulate, hispid-hirsute, apex acute, margin entire or shallowly dentate, base cordate with three palmate lobes; blade surfaces velvety texture. Petiole 2–5 cm long. Flowers solitary in axils, 4–5 cm wide, white with purple centre, 3 cm across, subtended by a prominent involucre of three pale green bracts; 1 – 3 pinnately segmented, sepals 5, white, linear, 1.5 cm long, pale; 5 linear petals; corolla collar or corona of two rows of purple filaments with white tips, connate and adnate to gynophores, anthers versatile, oblong and dorsifixed; carpels 3, syncarpous; styles 3, each with 2–3-lobed stigmas; ovary intermediate, 1-locular with many ovules; pedicels 3–7 cm long. Fruit indehiscent, berry or capsule, pale green turning yellow, orange, or reddish when ripe, globular, dry in flattened, 2–3 cm across, with thin leathery skinned, nearly 2 cm thick and enveloped by the shaggy involucreal pinnatifid bracts; seeds numerous, wedge-shaped to ovate, about 4 mm long, with coarse reticulate pattern centrally each side, seeds covered with scanty white, sweet, fragrant, mucilaginous and pulp.

Specimen examined: Sarawak, Serian Division, Kpg Sebemban, 20.08.2016, *Hidir Marzuki s.n.* (Herbarium Universiti Malaysia Sarawak)

Part used: Leaves and fruits

Traditional use and preparation: The whole plant, which consists of leaves, roots and fruits was soaked in water and taken for a bath.

Notes: *Physalis* is a genus of flowering plants in the nightshade family (Capsicum). Many of the species are cultivated for fruits and also as ornamental plants. In China, *Physalis* is used to treat abscesses, coughs, fever and sore throat. *Physalis foetida* is a common species in degraded areas and open spaced along roadsides. Preliminary screening of bioactive compounds for this study has detected phenol, quinine and emodin.

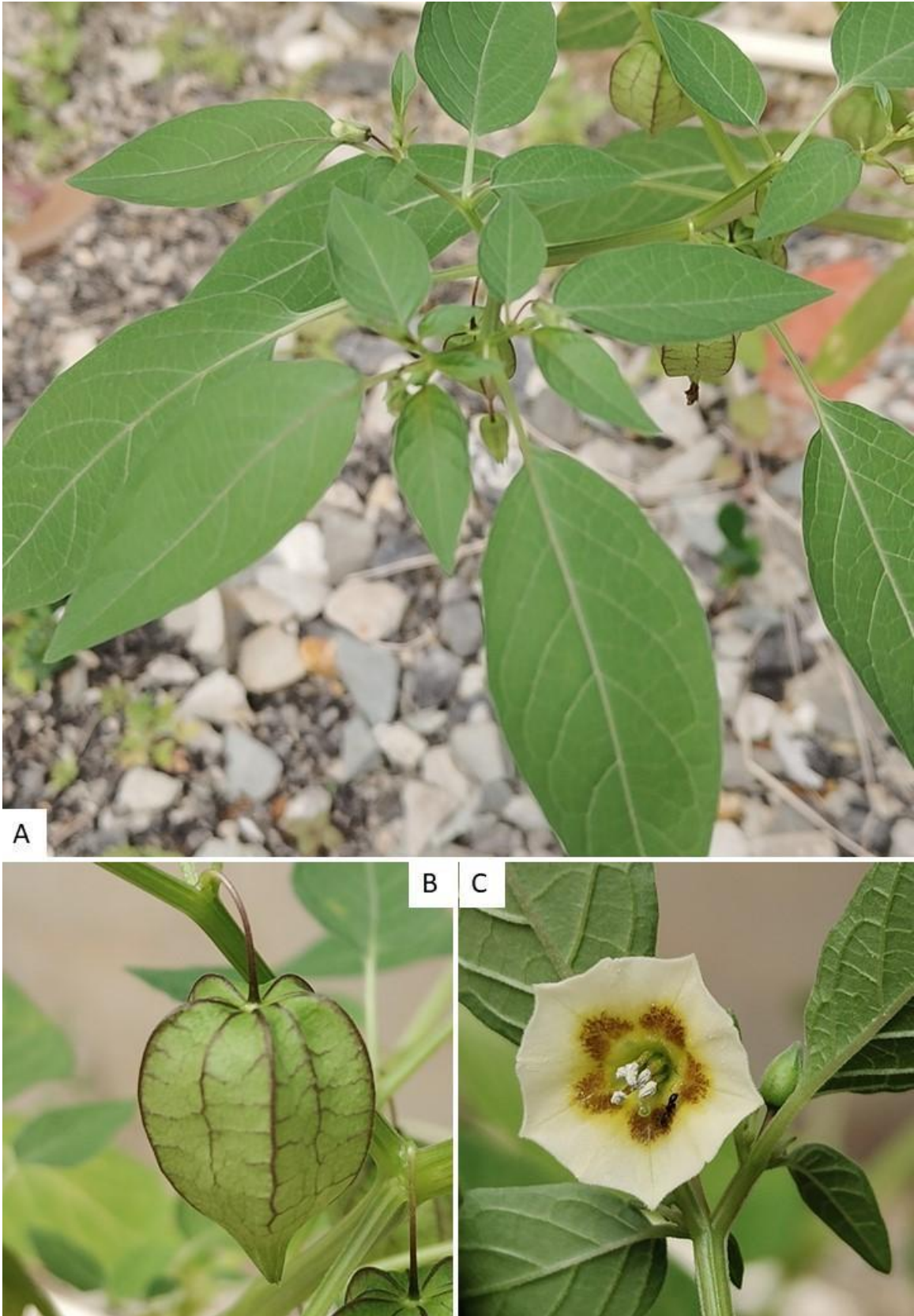


Figure 4.45: *Physalis foetida* L. a). part of plant, b). close up of fruit and c). close up of flowers

***Phaleria macrocarpa* Boerl.**

Family: Thymelaeaceae

Vernacular name: Mahkota Dewa (Mal.), Crown God (Eng.), Drug Lord (Eng.)

Synonym: *Phaleria calantha* Gilg., *P. papuana* Warb. ex K. Schum., *P. papuana* Warb. ex K. Schum. var. *wichmannii* (Val.) Backer, *P. wichmannii* Val.

Distribution: Native to Indonesia, Papua New Guinea and the northern part of Australia.

Description: Small bushy evergreen shrub, about 1–5 m tall (sometimes taller), 5–8 cm in diam., erect trunk, cylindrical, bark smooth or slightly wrinkled, brownish and crown dense. Leaves simple, opposite or sub-opposite arrangement, elliptic to oblong-lanceolate, 7–15 x 3–5 cm, apex pointed, coriaceous, dark green. Inflorescence umbel type, peduncle 3 – 20 mm, borne in the axil of leaves, carrying 2 – 5 white sessile flowers. Flowers are round or elliptical in shape. Mature fruit 3 – 5 cm in diam., green turned to brightly red or maroon when ripe.

Specimen examined: Kpg Tian Mawang - cultivated, 20.08.2016, *Hidir Marzuki s.n.*

(Herbarium Universiti Malaysia Sarawak)

Part used: Leaves and fruits

Traditional use and preparation: The leaves were boiled, and the drink was used for intestinal infection and allergy. Fruits were sliced and dried to make tea.

Notes: Cultivated as a medicinal plant. Susilawati et al. (2011) and Norzahirah et al. (2019) reported that the leaf of *Mahkota Dewa* contains methoxybenzophenone.



Figure 4.46: *Phaleria macrocarpa* Boerl. a). whole plant, b). leaves, c & d). ripe fruits

***Leea indica* (Burm. f.) Merr.**

Family: Vitaceae

Vernacular name: Kiruang (Bid. Ser.); Bandicoot-berry (Eng.); Kayu kenupan (Pen.); Kemali (Ib.); Mali-mali, Memali (Mal.)

Synonym: *Aquilicia sambucina* L. *illeg.*; *Leea biserrata* Miq.; *L. celebica* Clarke; *L. divaricata* T. & B.; *L. expansa* Craib; *L. fuliginosa* Miq.; *L. gigantea* Griff.; *L. gracilis* Lauterb.; *L. longifolia* Merr.; *L. naumannii* Engl.; *L. novoguineensis* Val.; *L. ottillis* (Gaertn.) DC.; *L. palambanica* Miq.; *L. pubescens* Zipp. *ex* Miq.; *L. ramosii* Merr.; *L. robusta* Blume; *L. roehrsiana* Sanders *ex* Masters; *L. sambucifolia* Salibs.; *L. sambucina* var. *biserrata* (Miq.) Miq.; *L. sambucina* var. *heterophylla* Zipp. *ex* Miq.; *L. sambucina* var. *occidentalis* Clarke; *L. sambucina* var. *robusta* Miq.; *L. sambucina* var. *roehrsiana* (Sanders *ex* Masters) Chitt.; *L. sambucina* var. *simplex* Miq.; *L. sambucina* var. *sumatrana* (Miq.) Miq.; *L. staphylea* Roxb.; *L. sumatrana* Miq.; *L. sundaica* Miq.; *L. sundaica* var. *fuliginosa* (Miq.) Miq.; *L. sundaica* var. *pilosiuscula* Span. *ex* Miq.; *L. sundaica* var. *subsessillis* Miq.; *L. umbraculifera* C.B. Clarke; *L. viridiflora* Planch.; *Staphylea indica* Burm. *f.*

Distribution and Ecology: Widely distributed throughout tropical Asia, to Australia and southwest of the Pacific. Common in many types of vegetation, in a disturbed and undisturbed forest of mixed dipterocarp forest, swamp and submontane forests up to 1200 m altitudes. Usually on alluvial soils near streams and rivers, and also on limestone (Tropical Plant Database, 2021).

Description: Shrub, treelet or small tree which is measuring 2-10 m tall, with many- or single-stemmed, frequently stilt-rooted while its stems are smooth to pubescent (Fem et al. 2017). The leaves are 2-3 pinnate, 7-numerous leaflets, with a size of measure 10-35 cm long rachis with 10-35 cm long rachis and with 10-25 cm long petiole. The obovate stipules are

up to measure 6 cm x 4 cm, early caducous, usually hairless, ovate-oblong to ovate-lanceolate shaped or elliptical to elliptical-lance-shaped leaflets, with a size of measuring 10-24 cm x 3-12 cm, wedge-shaped base to rounded, acute to acuminate apex, serrate to shallowly dentate margin, with small pearls-glands, inconspicuous and rapidly caduceus. The cyme is measured about 10-25 cm long, usually lax, sometimes compact and hairless to pubescent. The bracts are deltoid to pubescent. The bracts are deltoid to narrowly triangular and up to measure 4 mm long. The flowers are greenish-white, measuring about 2-3 mm x 3-4 mm sepal and they are smooth to pubescent. The staminodial tube is measured about 2-2.5 mm long and the upper free part is about 1-2 mm long, with shallowly retuse lobes, notched or cleft and shallow sinuses. The ovary is 6-celled. The purple-black berry is measured 5-10 mm in diameter and it is 6- seeded. The seed is with a size measure of 5 mm x 4 mm.

Specimen examined: Sarawak, Serian Division, Kpg Murud Mawang, *Hidir Marzuki s.n.* (Herbarium Universiti Malaysia Sarawak).

Part used: Leaves, shoots and roots.

Traditional use and preparation: Leaves are used to treat body pain, cuts, fever, skin complaints, and vertigo wounds. Decoction of young shoots used to treat sores. Beating the body with leafy shoots is believed to cure body pains, fevers and insomnia. Young leaves, crushed and pasted on scabies and itchy area.

Notes: Previously placed as a separate family (Leeaceae), and based on the molecular evidence, now a member of the grape family (Vitaceae). The genus *Leea* is considered a pioneer species, as they frequently found in secondary vegetation (Tropical Plants Database, 2021). Preliminary screening of bioactive compounds for this study has detected phenol in and emodin.

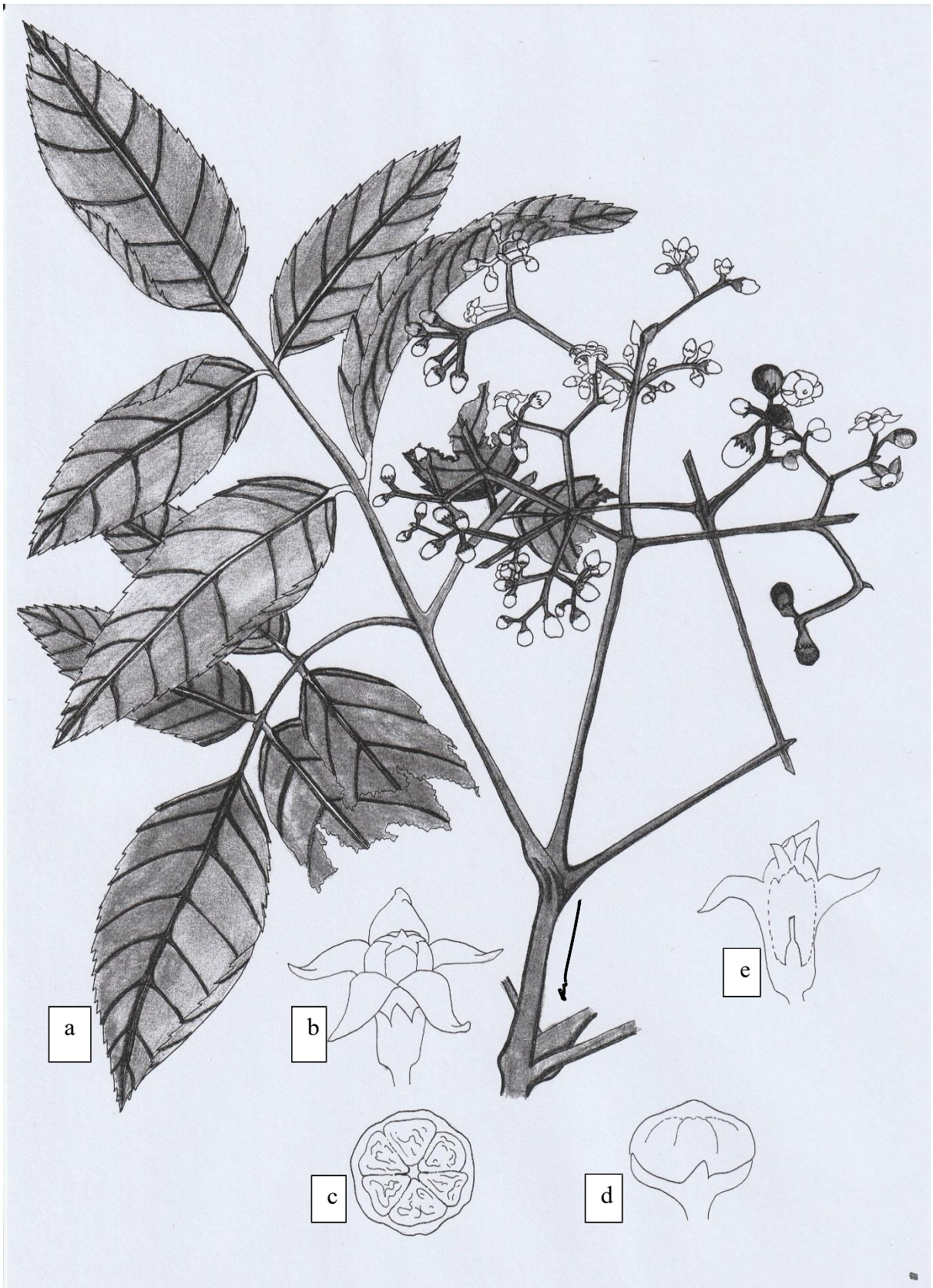


Figure 4.47: *Leea indica* (Burm. f.) Merr. a). leaf, b). flower, c) cross section of fruit, d). fruit and e). close up of flower



Figure 4.48: *Leea indica* (Burm.f.) Merr. A: leaves (seedling plant), B: fruits

***Curcuma longa* L.**

Family: Zingiberaceae

Vernacular name: Kunyit siew (Bid.); Kunyit (Mal.)

Synonym: *Amomum curcuma* Jacq.; *Curcuma brog* Val.; *C. domestica* Val.; *C. longa* var. *vanaharidra* Velay, Pandray, J.K. George & Varapr.

Distribution and Ecology: This species originates from Java, Indonesia and the spreading throughout Southeast Asia to Indo-China, India, China, Japan, Korea, the United States and some countries in Europe. Planted as an ornamental plant or purposely for medicine used in the backyard garden. Rhizomes developed well in the loose soil.

Description: Robust perennial herb, *ca.* 1 m tall with several leafy stems rising in a cluster from thick rhizome, form a large clump. Rhizome (tuber) fleshy, ellipsoidal, at the base of each aerial stem, ringed with the bases of old scale leaves. Inner rhizome bright orange in colour, young white, spicy smell when rhizome bruised, produced yellow sap when cut. Leafy shoots alternate distichous, bearing 8–12 leaves. Leaves large, oblong-lanceolate, 50–75 x 25–35 cm, apex acuminate, base broadly acute, margin entire, thin, dark green above, midrib green, very light green below, densely studded with pellucid dots. Petioles up to 15 cm long, broadly furrowed with narrow erect wings along the margins. Inflorescence from the rootstock, 30–45 cm long (or more), peduncle 10–15 cm long, head 15–20 cm long, 5–8 cm wide, with many light green-yellow bracts. Flowers are yellow-white, borne on a spike-like stalk 10-15 cm long. Flowers are sterile and do not produce viable seeds. Seeds are small, ovoid, and brown. Not viable

Specimen examined: Sarawak, Serian Division, Kpg Ranchan, *Hidir Marzuki s.n.*

(Herbarium Universiti Malaysia Sarawak).

Part used: Rhizome

Traditional use and preparation: Rhizomes have various uses in traditional medicine for the Bidayuh people, such as to treat ailments (stomach aches, common cold, inflammation and skin infections). The crushed rhizomes are pasted on the affected area or rubbed on the eyelid to treat sore eyes. The rhizomes are also, used to treat arthritis (Meekiong & Asaruddin, 2021).

Notes:

Preliminary screening of bioactive compounds for this study has detected phenol and emodin.

***Curcuma zedoaria* (Christm.) Roscoe**

Family: Zingiberaceae

Vernacular name: Tamu buda (Bid. Ser.); white turmeric; Temu kuning (Mal.)

Synonym: *Costus luteus* Blanco; *C. nigricans* Blanco; *Amomum latifolium* Salibs.; *A. zedoaria* Christm.; *Curcuma malabarica* Velay, Amalraj & Mural.; *C. pallida* Lour.; *C. raktakanta* Mangaly & M. Sabu; *C. speciosa* Link; *Erndlia zerumbet* Giseke; *Roscoea lutea* (Blanco) Hassk.; *R. nigrociliata* Hassk.

Distribution and Ecology: This species has a very long history, has been utilized since prehistorical times and is widely distributed in Asia to Madagascar and the Pacific islands. Cultivated mostly in the backyard gardens and orchards, preferably semi-shaded and well-drainage soils.

Description: Perennial herb to about 1 m tall, rhizome thick and ringed with the bases of old leaves. Rhizome yellow-white within. Each leafy shoot bears 8–12 leaves. Leaves blades narrowly ovate or elliptic, 15–30 x 7–15 cm, apex acuminate, margin entire, base cuneate, upper surface dark green, lower pale green. Inflorescence erect, 5–10 cm; bracts of main axis whitish proximally, green at base or pink, ovate to rectangular, deeply saccate, 4–5 cm long, apex obtuse or truncate-apiculate; distal bracts narrowly ovate, 4–4.5 cm long, apex rounded. Flowers, perianth white or spotted with purple; staminodes pale yellow with a yellow streak down the centre of the labellum; peduncle 10–15 cm long, slender, greenish. Flowers are sterile and do not produce viable seeds. Seeds are small, ovoid, and brown.

Specimen examined: Sarawak, Serian Division, Kpg Rayang, 15 Sept 2016, *Hidir Marzuki* s.n. (Herbarium Universiti Malaysia Sarawak)

Part used: Whole plant, young shoot and rhizomes.

Traditional use and preparation: The young shoots and inflorescences are shredded and eaten raw to treat scabies. The rhizomes are crushed and pasted on wounds or other skin ailments.

Notes: *Curcuma zendorfia* is occasionally used as a houseplant. Sometimes planted as ornamental plants because of outstanding beautiful inflorescence. The flowers are yellow with red and green bracts. In other places in Sarawak, this species is also planted near the paddy fields or orchards. The folks believe that planting this plant will cast the evil spirits/or unwanted spirits away. Preliminary screening of bioactive compounds for this study has only detected emodin.

***Curcuma xanthorrhiza* Roxb.**

Family: Zingiberaceae

Vernacular name: Temu labak (Bid. Ser.); Temu lawak (Mal.); Java ginger, Javanese ginger, Javanese turmeric (Eng.)

Synonym: *Curcuma xanthorrhiza* Roxb.

Distribution and Ecology: Origin from Java, Indonesia. Now, widely cultivated in Indonesia, Malaysia, the Philippines and Thailand, and outside Southeast Asia, such as China, Indochina, Barbados, India, Japan, Korea, the United States and some countries in Europe. Thriving in many habitats from sea level up to 1500 m above sea level. The rhizomes develop well in loose soils.

Description: Perennial herb, up to 2 m tall, erect; rhizome branched, ovate, with both palmate and pendulous tubers deep/dark yellow, orange or orange-red inside, paler on younger parts, pungent smell, taste bitter. Pseudostem to 70 cm, green composed of leaf sheaths and sheathed by 4–5 green bracts. Leaves semi-erect, oblong-lanceolate to elliptic-lanceolate, *c.* 30–100 x 12–30 cm, apex acuminate, slightly hairy, margin entire, base attenuate, decurrent, glabrous on both surfaces. Petiole 5–20 cm long, winged on both sides, glabrous. Inflorescence invariably lateral, up to 25 cm, on separate shoots arising from rhizomes; peduncle 10 - 30 cm; 8–20 mm diam., spike 16–25 x 8–10 cm; fertile bracts pale green, *ca.* 1.4 cm, pubescent, apex 3-toothed; corolla tube *ca.* 3.5 cm, lobes pale purple, ovate, *ca.* 1.7 x 1.5 cm. Coma large, and of deep purple, or crimson colour; coma bracts dark pink; flowers yellow with pinkish corolla lobes exterior border of the corolla red; lateral staminodes yellowish tinged with purple, oblong, *ca.* 1.7 x 1 cm; labellum yellowish with deeply coloured, median band, square, *ca.* 2 x 2 cm; anther 4–5 mm, base with spur 3–3.5

mm. Roots short with large tubers; the shape of rootstock oblong, short, colour reddish-yellow.

Specimen examined: Sarawak, Serian Division, Kpg Sorak Sampung, 21 Aug 2016, *Hidir Marzuki s.n.* (Herbarium Universiti Malaysia Sarawak)

Part used: Whole plants, rhizomes and leaves.

Traditional use and preparation: The people of Kampung Sorak Sampung used young shoots or inflorescence mixed with sugar and rice to treat blotted stomachs. While the people of Plaman Baki also used the cabbage to treat stomachache or itchiness. The people of Kampung Ranchan also used cabbage, mixed with *Blumea balsamifera* to treat asthma.

Notes: This species is intensively used for medicinal and nutritional purposes and is a popular plant for laboratory experiments. Preliminary screening of bioactive compounds for this study has detected phenol and emodin.

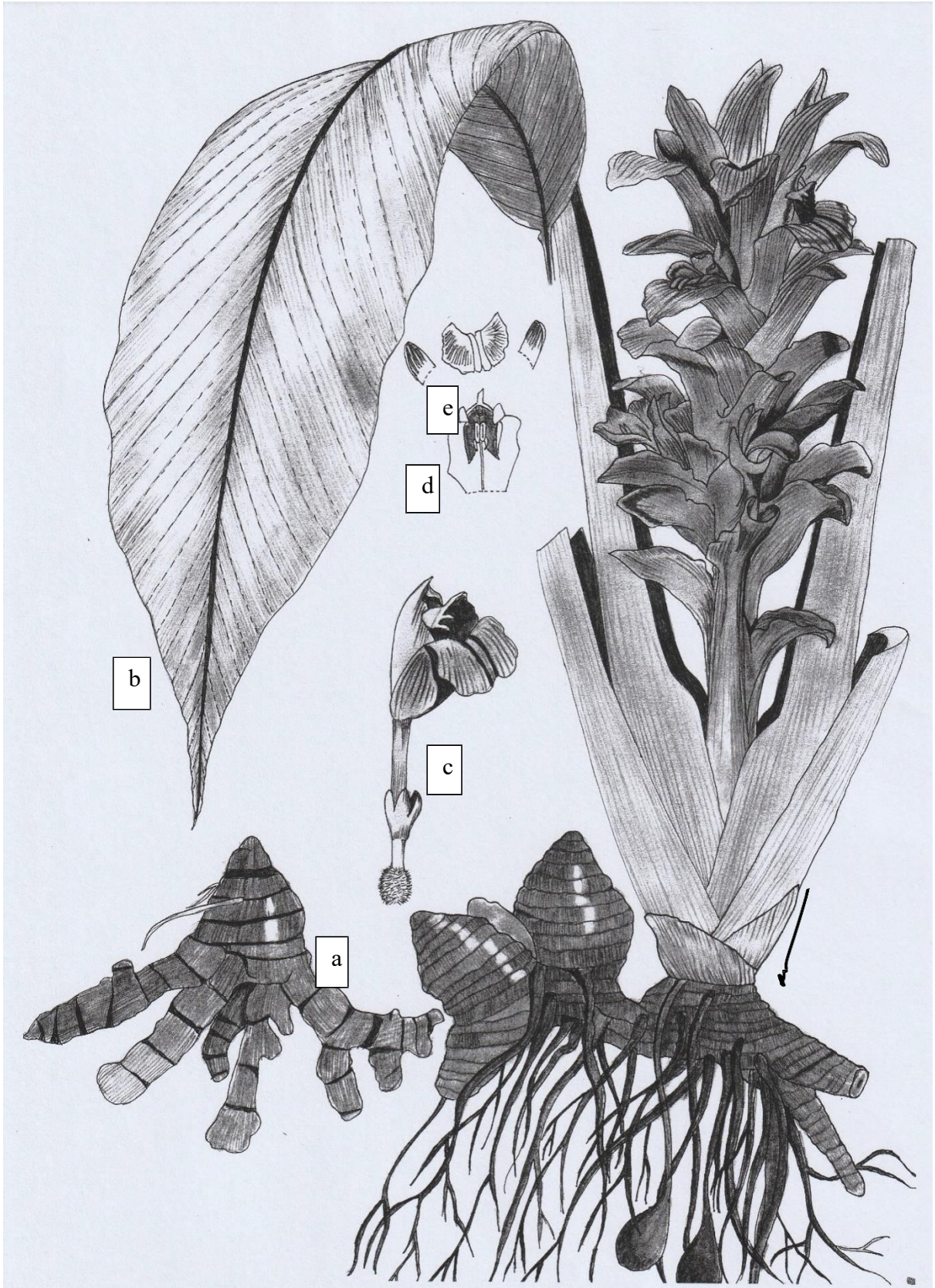


Figure 4.49: *Curcuma longa* L. a). rhizome, b). leaf, c). flowers, d). close up of flowers, e). seed and f). flowers

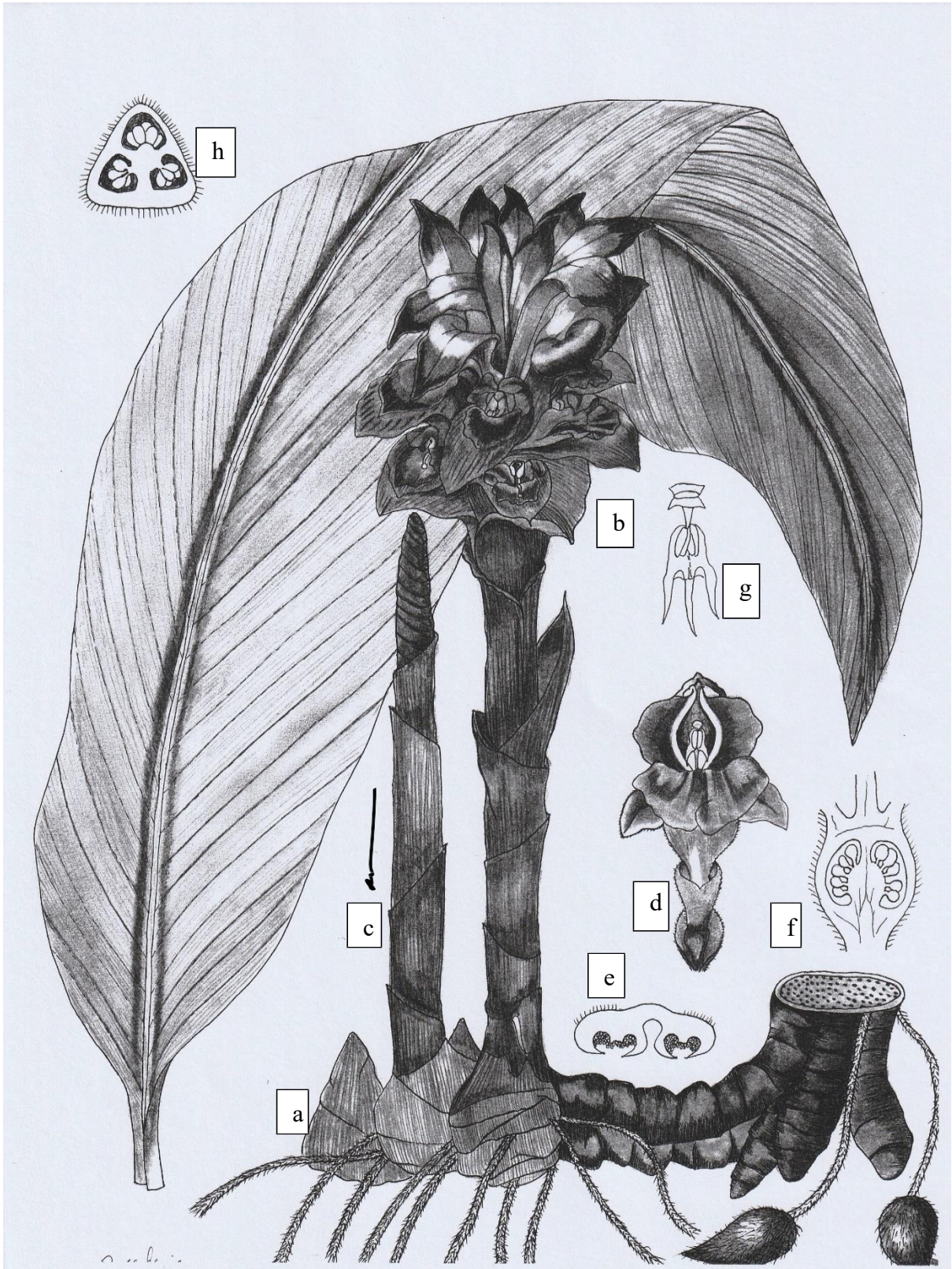


Figure 4.50: *Curcuma zendorfia* (Christm.) Roscoe. a). rhizome, b). flowers, c). young shoot, d). close up of flower, e) seed, f). cross section of ovul, g). anther and h). cross section of seed pod

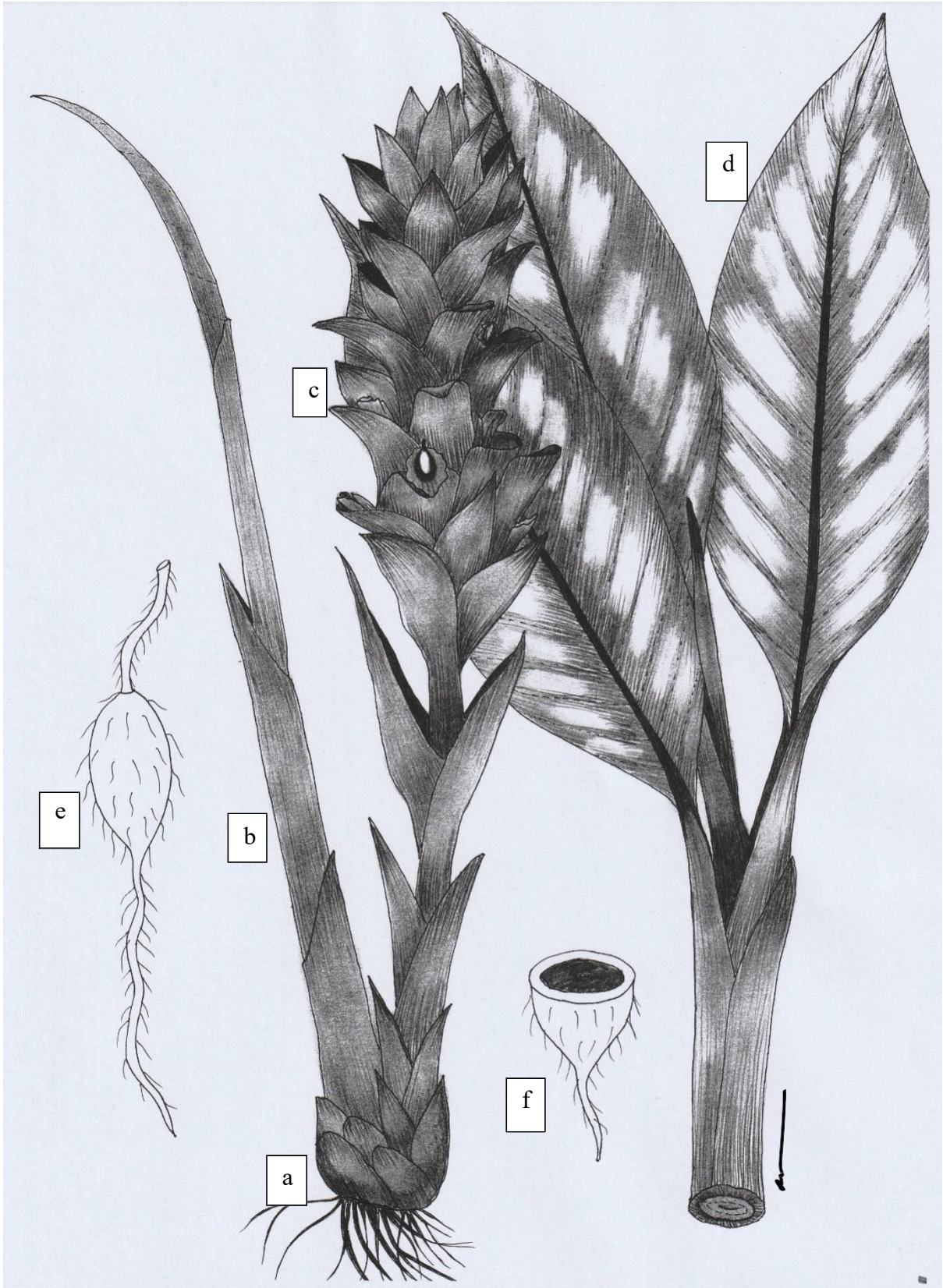


Figure 4.51: *Curcuma xanthorrhiza* Roxb. a). rhizome, b). young shoot, c). flowers, d). leaf
e). spike and f). cross section of spike

***Kaempferia galanga* L.**

Family: Zingiberaceae

Vernacular name: Sakur, Cakur (Bid. Ser.); Cekur, Chekur, Cengkur, Kencur (Mal.); Galanga, Aromatic ginger, Sand ginger, Resurrection lily (Eng.)

Synonym: *Alpinia sessilis* J. Koenig; *Kaempferia humilis* Salibs.; *K. latifolia* Donn ex Hornem.; *K. marginata* Carey ex Roscoe; *K. plantaginifolia* Salibs.; *K. procumbens* Noronha; *K. rotunda* Blanco

Distribution and Ecology: widely spread as a cultivated herb in Southern China, Taiwan, India and throughout Southeast Asia. Planted in numerous types of soils, but preferable in shade areas.

Description: Small perennial herb, low-growing, stemless or very short stem, 5–25 mm long, up to 45 cm tall from a rhizomatous rootstock. Rhizome thick, aromatic, pale green or greenish white inside, fleshy, tuberous and fragrant. Rounded leaves usually lay flat in a rosette on the ground. Leaf-sheath 1.5–5 cm long, foliage typically consists of 2–3 (sometimes up to 5), broadly elliptical to suborbicular, 6–15 x 5–10 cm, apex acuminate or slightly rounded, margin entire, base rounded, upper surface green to dark green, corrugated, lower surface pale green, arachnoid-hairy. Inflorescence terminal, emerging from between the leaves, sessile; composed of 4–12 flowers, in cluster. Flowers white with purplish spots in the axillary fascicles, corolla tube 2.5–2.8 cm long, connective of anther produced into a quadrate two-lobed appendage; lobes 1.5–3 cm long, labellum broadly obovate, divided into halfway or more, white or pale purple with violet to purple spots at base; lateral lobe, 2–2.5 x 1.5–2 cm; other staminodes oblong-obovate to oblanceolate, 1.5–3 cm long, white. Fruits oblong, 3-loculed and 3-valved capsules, seeds arillate.

Specimen examined: Sarawak, Serian Division, Kpg Ranchan, *Hidir Marzuki s.n.*

(Herbarium Universiti Malaysia Sarawak)

Part used: Rhizomes and leaves.

Traditional use and preparation: The rhizome and leaves are pounded and applied as a poultice or lotion to treat a variety of disorders such as sprains, swelling, ulcers, headaches and stomach aches.

Notes: The decoctions and the sap of the leaves contain unidentified chemical compounds that may have hallucinogenic properties. Preliminary chemical analysis of bioactive compounds for this study has detected Phenol and Emodin.

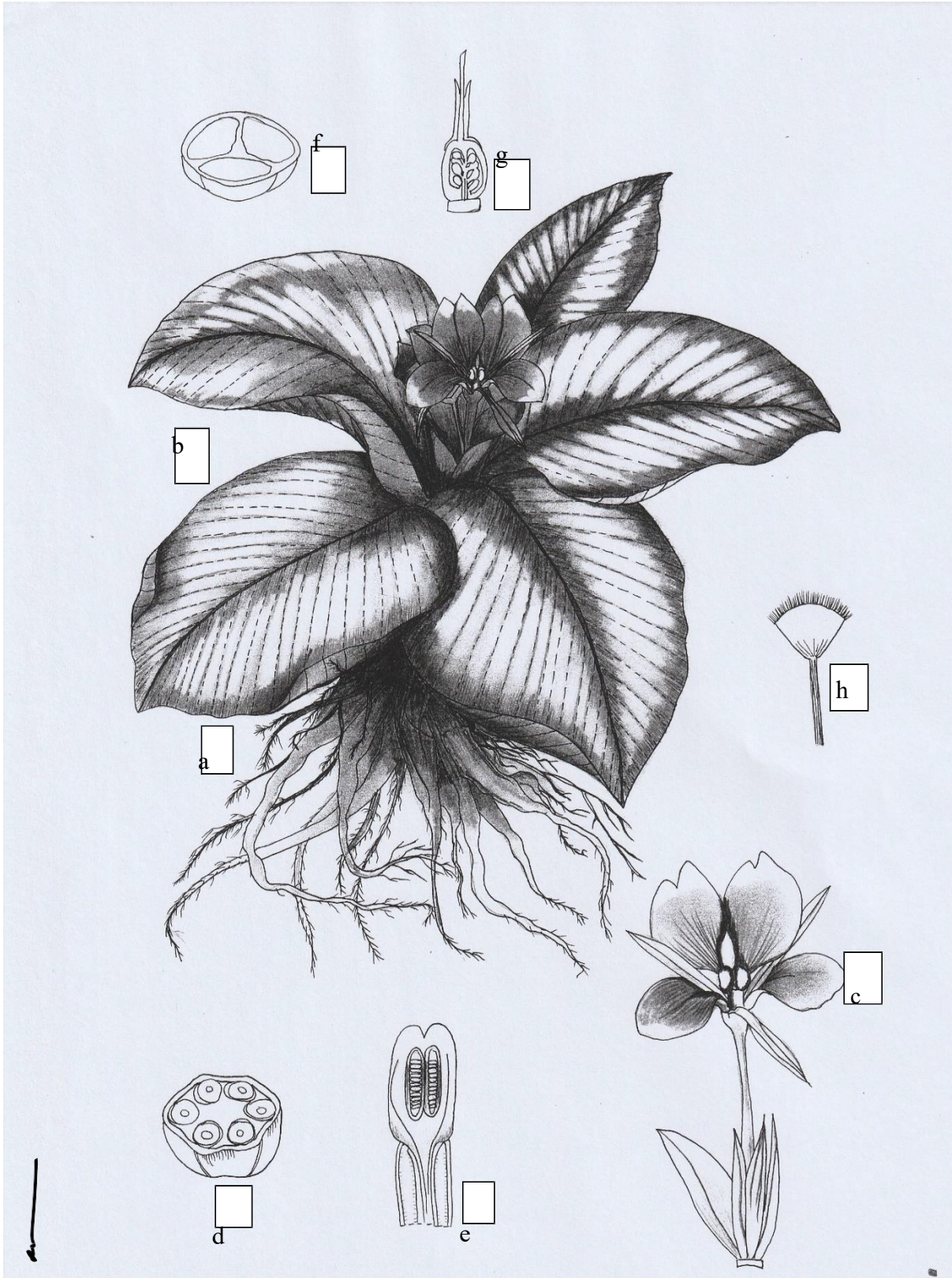


Figure 4.52: *Kaempferia galanga* L. a). rhizomatus root stock, b). leaf, c). close up of flower, d). cross section of seed, e). seed, f). cross section of ovul, g). ovul and h). anther

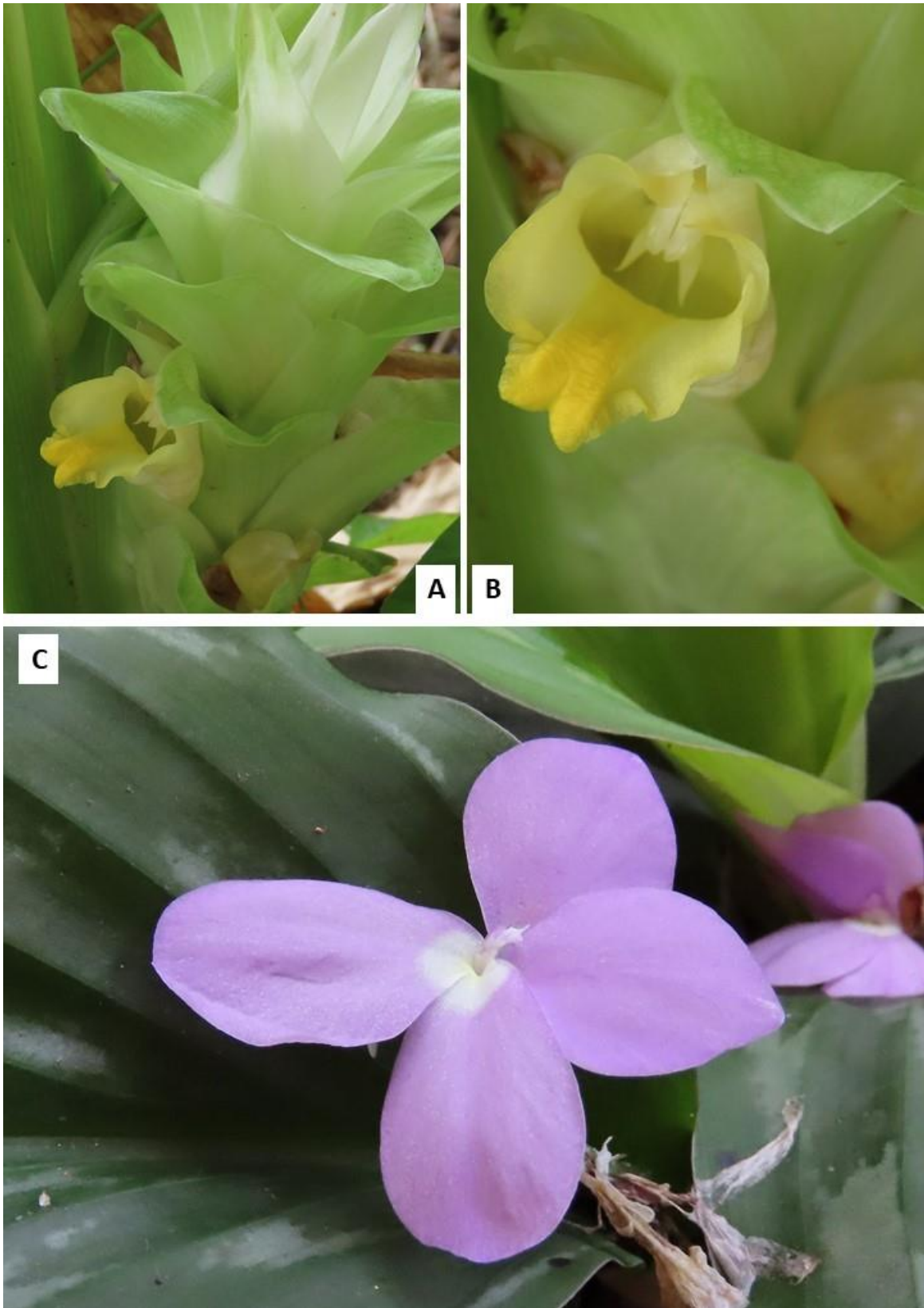


Figure 4.53: A: Inflorescence of *Curcuma longa*, B: close-up flower of *Curcuma longa*, C: close-up flower of *Kaempferia galanga*

4.5 Thematic Analysis on the medicinal plants used by the Bidayuh Bukar-Sadong in Serian

Overall willingness to share across all zones with 268 respondents were willing to share information, while 119 were not. Analysis on the willingness to share by village as follow;

- Kpg Murud Mawang had more respondents willing to share (53.8%) than not willing (23.1%).
- In contrast, in Kpg Plaman Baki, a smaller percentage were willing to share (39.4%) compared to those with "zero-knowledge" (48.5%).
- In the Tarat zone, Kpg Rayang and Kpg Ampungan had a much higher percentage of "zero-knowledge" respondents compared to those willing to share (21.5% and 20.5%, respectively).

The pattern in willingness varies significantly between villages and zones. Some villages such as Kampung Murud Mawang, Kampung Tian Mawang, and Kampung Pasir Stabun, show a higher percentage of people willing to share compare to those unwilling. Conversely, other villages, like Kampung Mang Besi and Kampung Ranchan, show a lower percentage of people willing to share compared to those not willing.

On the educational level, the largest group of respondents had a secondary school education (119 out of 268 respondents). This was followed by no education (96 respondents) and primary school (39 respondents). A smaller number of respondents had a university/college education (12 respondents) or attended an adult class (1 respondent). On occupation, the most occupation among respondents was “farmer,” with 117 out of 268 respondents. The next group was housewife (46 respondents), followed by “others” (75 respondents). Retired government staff and current government staff each accounted for 15 respondents.

Based on Rubric Scoring (Table 4.5), it shows that the sharman representatives are :

- i. Proficient (Score 3) in term of Plant identification: Can accurately identify several medicinal plants, including key distinguishing features. Identifies plants using both common and local names.
- ii. Expert (Score 4) in term of Application and Preparation: Provides detailed, precise instructions on preparation methods, including specific parts of the plant to use, and can explain the reasoning behind different methods.
- iii. Expert (Score 4) in term of Safty and Consistency: Demonstrates a thorough understanding of safety, including potential interactions with other herbs or medications. Can provide consistent, reliable guidance on dosage for different conditions.
- iv. Proficient (Score 3) in term of Depth Knowledge: Can provide a detailed explanation of the uses of several plants, explaining the specific conditions they are used for and the historical context of their use.

Table 4.5 : Rubric Scoring on the knowledge of medicinal plants by the Bidayuh Bukar-Sadong communities in Serian

Criteria	Score 1 (Novice)	Score 2 (Basic)	Score 3 (Proficient)	Score 4 (Expert)
Plant Identification	The person struggles to correctly identify common medicinal plants, or their identifications are consistently incorrect.	Can identify a few common medicinal plants by sight, but may confuse similar-looking species.	Can accurately identify several medicinal plants, including key distinguishing features. Identifies plants using both common and local names.	Accurately identifies a wide range of medicinal plants. Can distinguish between closely related species and uses both scientific and local names with confidence.
Application and Preparation	The person has a vague or incorrect understanding of how the plants are used and prepared. Their methods are inconsistent.	Has a general idea of a plant's use (e.g., "for a cough") but lacks specific details on how to prepare it (e.g., as a tea, poultice, or tincture).	Demonstrates a consistent and correct understanding of how to prepare and apply specific plants for their intended use.	Provides detailed, precise instructions on preparation methods, including specific parts of the plant to use, and can explain the reasoning behind different methods.
Safety and Consistency	The person is unaware of potential risks, side effects, or correct dosages. Their information is often contradictory or unsafe.	Is aware of basic risks (e.g., "don't eat too much") but lacks knowledge of specific contraindications, dosages, or how to avoid common side effects.	Consistently provides correct information on proper dosage, preparation to reduce risk, and common contraindications for specific plants.	Demonstrates a thorough understanding of safety, including potential interactions with other herbs or medications. Can provide consistent, reliable guidance on dosage for different conditions.

Table 4.5 continue

Depth of Knowledge	The person's knowledge is limited to simple, often unverified claims (e.g., "this plant is good for everything").	Has a surface-level understanding of a few plant uses, but cannot elaborate on the mechanism of action or the specific ailments they treat.	Can provide a detailed explanation of the uses of several plants, explaining the specific conditions they are used for and the historical context of their use.	Exhibits a comprehensive, interconnected understanding of plant uses. Can discuss the broader context of medicinal plants, including their cultural significance and historical use.
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For a more in-depth study, to ascertain whether the facts provided are accurate and reliable, a scoring rubric was used for individuals willing to share their knowledge. This rubric assessed their comprehension in four key areas: plant identification, preparation and usage, safety, and in-depth knowledge (as detailed in the rubric table above).

Of the 268 respondents who were willing to share their knowledge, almost all demonstrated a high level of proficiency in plant identification, achieving a score of 3. Nearly all respondents also scored a 4 for their knowledge of preparation and usage, indicating a clear understanding of how to prepare and use the plants. The safety aspect of their knowledge received a score of 3, with 15 percent of respondents expressing uncertainty about long-term effects. Overall, almost all participants possessed profound knowledge regarding plant identification, usage, and application methods. In conclusion, the data collected from this study is considered reliable and accurate.

4.6 General Discussion

4.6.1 The Serian Bidayuh (Bukar-Sadong) Communities

The Bidayuh ethnic group is the majority, with approximately 65% of the total 90,763 residents registered in the Serian Division (census 2010). They were found in all four administrative zones (Muara Tuang, Siburan, Tarat, Kedup, and Tebedu), with the majority actively engaged in agricultural activities and mostly occupying rural and suburban areas. They are still abstemiously relying on natural resources, such as food, medicines, and construction materials. However, with massive development and rapidly changing technologies, the traditional knowledge among the Bidayuh (Bukar-Sadong) communities of the Serian division seems to be on the brink of evaporating.

4.6.2 Comparison of Medicinal Plants Among the Bidayuh Communities

A comparison of the documentation of medicinal plants used by the Bidayuh community in Sarawak was conducted by cross-referencing this study with previous reports. Table 4.6 below summarizes this comparison. Recent documentation by Patrick et al. (2022) recorded 44 species of medicinal plants used by the Bidayuh community in Bau, Padawan, and Siburan. In contrast, an ethnobotanical documentation for the Bidayuh community (Bau and Padawan) by Meekiong et al. (2021) recorded a total of 303 species, of which 142 species were identified as medicinal plants.

A broader documentation by Chai (2006) recorded 608 species of medicinal plants across various ethnic groups in Sarawak, with 168 species being used by the Bidayuh community. However, Chai (2006) did not specify the Bidayuh sub-ethnic group or location. In a more focused study, Martin (1997) specifically listed 44 species of medicinal plants used by

the Bidayuh community in Bau (Jagoi), which was later updated by Ripen and Noweg (2016) with the addition of 16 species, bringing the total to 60 species for the Bidayuh community in Bau (Jagoi).

Table 4.6: Comparison of Medicinal Plants Among the Bidayuh Communities

Documentation/references	Number of species recorded	Bidayuh (sub-ethnic/locality)
Chai (2006)	608 spp. (168 spp. medicinal plants)	General
Martin (1997)	44 spp. (medicinal plants)	Bau (Jagoi)
Meekiong et al. (2021)	303 spp. (142 spp. medicinal plants)	Bau and Padawan
Patrick et al. (2022)	44 spp. (medicinal plants)	Bau, Padawan, Siburan
Ripen & Noweg (2016)	117 spp. (60 spp. medicinal plants)	Bau (Jagoi)
This study (2025)	126 spp. (medicinal plants)	Serian (Bukar-Sadong)

The comparison of the number of documented plant species shows the significance of the current study (Bidayuh Bukar-Sadong), as there were no prior records specifically related to the Bidayuh Bukar-Sadong sub-ethnic group. This information will be highly valuable for future researchers conducting follow-up studies.

4.6.3 Solution on the Zero-Knowledge and Knowledge Preservation

From this study, it was found that the knowledge of the Bidayuh Bukar-Sadong community regarding the use of plants in traditional medicine is eroding. A high percentage of individuals within this community possess zero knowledge, with an average of 42% recorded across all study zones. This finding is consistent with research by Abdul Rahman et al. (2019) and Yinghe and Yeo-Chang (2021), who suggest that urbanization and cultural modernization

are key factors contributing to the erosion of traditional knowledge. The UNDP (2025 onwards) emphasizes the importance of preserving traditional knowledge, as it is highly significant in managing global climate change. Therefore, it is crucial to find solutions to address the erosion of traditional knowledge among the Bidayuh Bukar-Sadong and other ethnic groups in Sarawak.

Proposed Solutions for Knowledge Preservation

Several strategies are proposed to mitigate the loss of traditional knowledge.

Integration into Education

One proposed solution is the integration of traditional knowledge into the school curriculum. This approach should begin at an early age to instill appreciation and a sense of responsibility for preserving this heritage. However, the implementation of such an initiative requires high-level discussions involving the Ministry of Education and relevant policymakers and stakeholders.

Intensive Documentation

Another critical solution is intensive documentation. Studies like this one can record information from individuals who possess traditional knowledge. This documentation must be carried out intensively and collaboratively with relevant parties such as museums, archives, educational institutions, and media outlets (e.g., TV channels) to capture this knowledge before it is lost forever.

Intellectual Property Protection

Protecting the rights to traditional knowledge is also essential. According to Hew and Hara (2006), one factor preventing local communities from sharing their traditional knowledge is the fear that it will be misused. To encourage knowledge sharing, relevant authorities must establish

and implement policies to protect these intellectual rights, such as the Sarawak Biodiversity Ordinance.

4.6.4 Conservation and Sustainability Challenges

Despite the wealth of knowledge and biodiversity, Borneo's medicinal plant collections face significant threats due to deforestation, habitat destruction, and climate change. The rapid expansion of palm oil plantations and logging activities is leading to the loss of vital ecosystems, putting both the plants and the traditional practices of indigenous communities (including the Bidayuh Bukar-Sadong) at risk. Additionally, overharvesting of certain species (such as *Tongkat Ali* and *Kacip Fatimah*) for commercial use can deplete local populations, further endangering their survival. Conservation efforts are essential to protect these invaluable resources. Initiatives that promote sustainable harvesting practices, establish protected areas, and support the rights of indigenous communities are vital for preserving both biodiversity and traditional knowledge, particularly on medicinal plants. Collaborative efforts between scientists, conservationists, and local communities can help ensure that the medicinal plants of Borneo are safeguarded for future generations.

Lack of Awareness

Lack of awareness among the new generations of the importance of traditional knowledge is one of the major concerns in this matter. With the fast-flowing development of technologies, new generations are more interested in gadgets than in taking care of traditional knowledge, which is tedious and uninteresting. The traditional knowledge, particularly on medicinal plants, is even harder. It requires a special skill; plant identification is relatively hard to attract the young generations. Based on the result of this study, one of

the reasons for unwillingness to share the information is that people are afraid of wrongly identifying plants or only know the names of plants from hearsay but do not know how the plant looks.

Sustainable Harvesting of Medicinal Plants

Sustainable harvesting of medicinal plants in Borneo, particularly Sarawak is crucial for preserving biodiversity, supporting local communities, and ensuring the continued availability of these valuable resources. Given the pressures of deforestation and overharvesting, implementing effective strategies for sustainable practices is essential. Some of the suggestions on the key approaches to achieve this goal:

i. Education and Training

Educating local communities about sustainable harvesting techniques is vital (WWF, 2021). Even younger generations must be educating on medicinal plants, importance and its value. This will make them aware of the decline of knowledge in traditional practices, educate them on the entrepreneurship possibilities from the traditional medicine knowledge, educate on in-situ and ex-situ conservation efforts and how they can play role in these. Training programs can teach collectors about the importance of maintaining plant populations and the ecosystem.

ii. Good Harvesting Practices

Implementing good harvesting practices is essential to minimize environmental impact (Deepa et al. 2018). This involves techniques such as selective harvesting, where only certain parts of the plant are taken, and ensuring that harvesting occurs at the right time of year to allow for regeneration. For example, collecting leaves or flowers instead of roots can help maintain the plant's ability to grow back.

iii. Community Involvement and Management

Involving local communities in the management of medicinal plant resources fosters a sense of ownership and responsibility. Community-based management systems can be established, where local knowledge is integrated into conservation efforts. This approach not only empowers communities but also ensures that traditional practices are respected and preserved.

iv. Regulatory Frameworks

Establishing and enforcing regulations regarding the harvesting of medicinal plants can help protect vulnerable species (Mir et al. 2021). This includes setting quotas, restricting harvesting during certain seasons, and designating protected areas where harvesting is prohibited. Such regulations can help prevent overexploitation and ensure that harvesting practices are sustainable.

v. Cultivation and Agroforestry

Encouraging the cultivation of medicinal plants through agroforestry practices can reduce pressure on wild populations (Zul Azlan et al. 2024). By integrating medicinal plants into agricultural systems, communities can meet their needs without depleting natural resources. This approach also promotes biodiversity and can enhance soil health and ecosystem resilience.

vi. Research and Monitoring

Researching the ecological impacts of harvesting practices is essential for developing sustainable strategies (Hernandez-Barrios et al. 2014; Ticktin, 2004). Monitoring plant populations and their health can provide valuable data to inform management decisions. This

research can also help identify which species are at risk and require additional protection.

4.6.5 Future Studies on the Malaysian Medicinal Plants

There is a growing need for continued research on the phytochemical properties of Malaysian medicinal plants. Advanced techniques such as metabolomics and molecular biology can uncover new bioactive compounds and elucidate their mechanisms of action. Collaborative efforts between researchers, traditional healers, and local communities can enhance the understanding and utilization of these plants in modern medicine. Phytochemicals from medicinal plants in Malaysia offer significant health benefits and play a crucial role in traditional medicine. Understanding their properties can lead to the development of natural alternatives to synthetic drugs and contributes to the preservation of cultural heritage.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The documentation on the traditional knowledge and the use of medicinal plants among the Bidayuh Bukar-Sadong communities in the Serian division has been successfully conducted. A total of 126 species from 104 genera and 56 plant families were recorded. The number was considered moderately high because it congregated only from 268 willing respondents or about 30.8% (out of 870 total respondents surveyed). The plants were used to treat about 71 diseases, with 53.9 per cent used externally and only 46.1 per cent consumed. Leaves and fruits were the most popular plant parts used or consumed. Out of the 126 species recorded, 20 plant taxa that are used to treat skin diseases were selected for further phytochemical screening investigation (to test the presence of five selected compounds: carvocrol, phenol, quinine, thymol, and emodin).

5.2 Recommendations

Albeit the documentation that has been done in this study from Bidayuh Bukar-Sadong communities in Serian division. There is still a lot to be documented and improved from time to time. Therefore, based on the experiences from this study, a few recommendations are given here:

- a. A serious effort needs to be made to attract the younger generation to learn and to document the traditional knowledge, particularly on medicinal plants. For example, a consideration of the botany subject should be introduced as early as the secondary stage of education. In this study, about 13.7% of the respondents were not willing to share their knowledge because they were afraid of wrongly identifying the plants.
- b. Proper screening and identification of bioactive from most utilized medicinal plants that have the potential to be commercialized.

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APPENDICES

Appendix 1: Data acquisition questionnaire for Ethnobotanical Study of Medicinal Plants Utilised by Bidayuh Serian (Bukar-Sadong), Sarawak Borneo.

Code no:

Data acquisition questionnaire for Ethnobotanical Study of Medicinal Plants Utilised by Bidayuh Serian (Bukar-Sadong), Sarawak Borneo.

PART 1: INFORMANTS DETAILS

Name:..... Sex: M/F Age:.....yrs
Ganan : *Dari/Dayung* *Umur:*
 Occupation:..... Level of education:.....
Kiraja: *Pidatuh sekolah:*
 Location/Residence:.....
Tempat/Tempat ramin:

PART 2: DATA ON MEDICINAL PLANTS AND ITS USES

Specimen no	Native name <i>(Ganan kampung)</i>	Habit <i>(Tree/herb/shrub /climer/....</i>	Part Used <i>(Bhg tinan)</i>	Disease Treated <i>(Kandam rian)</i>	Mode of administration <i>(Cara minan)</i>

PART 3: RESPONDENTS CONSENT AGREEMENT

I.....hereby agree to participate in this study with my full consent and conscious and declare that to the best of my knowledge the information that I have provided is true, accurate and complete.

Date :.....

Appendix 2: List of Respondents (willing to shared their traditional knowledge)

NO.	Name	Gender	Age	Education level	Occupation
1	Mary	F	68	MCE	Pensioner
2	Robert	M	59	LCE	Supervisor
3	Kiram	M	68	Senior Cambridge	Farmer
4	Norin	F	66	Junior Cambridge	Farmer
5	Josephine	F	41	SPM	Cleark
6	Will	M	48	Degree	Teacher
7	Florence	F	48	Degree	Teacher
8	Henry	M	59	LCE	Labourer
9	Sall	F	52	-	Farmer
10	Jally	M	65	Primary 6	Pensioner
11	Melah	F	63	Primary 6	Farmer
12	Judde	M	43	Diploma	Driver
13	Bujang	M	61	MCE	Supervisor
14	Rosalinde	F	51	SPM	Housewife
15	Gawin	F	65	-	Farmer
16	Irene	F	41	Degree	Teacher

17	Kenadie	M	56	SPM	Driver
18	Linda	F	55	SPM	Cleark
19	Carolina	F	47	SRP	Housewife
20	Mathew	M	49	SPM	Labourer
21	Lilyn	F	44	UPSR	Farmer
22	Romie	M	55	Primary 6	Labourer
23	Minnie	F	45	PMR	Farmer
24	Masour	M	56	LCE	Supervisor
25	Agnes	F	47	Primary 6	Housewife
26	Kerop	M	65	Senior Cambridge	Farmer
27	Ringeng	M	66	Primary 6	Pensioner
28	Jelimy	F	66	Primary 6	Farmer
29	Jelian	M	51	SPM	Labourer
30	Rosita	F	43	-	Housewife
31	Rijung	M	75	-	Farmer
32	Panchak	F	67	-	Farmer
33	Emilie	F	45	Degree	Teacher
34	Andrew	M	52	SPM	Pensioner
35	Lyila	F	48	SPM	Housewife
36	Pura	M	65	Primary 6	Farmer

37	Jennee	F	59	Primary 6	Farmer
38	Mackenzie	M	45	Degree	Teacher
39	Diana	F	42	STPM	Teacher Assistant
40	Bunsie	M	65	-	Farmer
41	Santap	F	63	-	Farmer
42	Jolanda	F	42	SPM	Nurses
43	Linpa	M	63	-	Farmer
44	Latin	F	62	-	Farmer
45	Jeffrey	M	41	SPM	Driver
46	Janeet	F	39	SPM	Supervisor
47	Rujah	F	77	-	Farmer
48	Andrew	M	48	SRP	Labourer
49	Salvestor	M	47	MBA	Freelance
50	Dommie	M	58	-	Farmer
51	Laura	F	50	-	Farmer
52	Nyesapak	F	66	-	Farmer
53	Miko	M	42	SPM	Labourer
54	Marina ak Buyu	F	49	Primary 6	Farmer
55	Rosate	M	39	SPM	Cleark
56	Petrus	M	41	SRP	Farmer

57	Maryiana	F	38	SPM	Farmer
58	Sateh	F	75	-	Housewife
59	Wilfred	M	50	SPM	Labourer
60	Wah	F	49	SRP	Labourer
61	Doris	F	52	SRP	Labourer
62	Edward	M	51	STPM	Supervisor
63	Johnes	M	45	SPM	Cleark
64	Dorrah	F	48	SPM	Cleark
65	Sylvester	M	45	Primary 6	Labourer
66	Rocky	M	54	SRP	Farmer
67	Micheal	M	50	SRP	Driver
68	Emelia	F	48	SPM	Farmer
69	Lucia	F	49	SRP	Farmer
70	Alice	F	52	SPM	Housewife
71	Richard	M	51	SPM	Driver
72	Ernie	F	41	Degree	Supervisor
73	Julau	F	61		Farmer
74	Paul	M	33	SPM	Driver
75	Natalia	F	31	SPM	Waitress
76	Rayan	M	68	Primary 6	Farmer

77	Rosina	F	63	Primary 6	Farmer
78	Livi	F	36	SPM	Teacher assistant
79	Olium	F	44	SPM	Pensioner
80	Junit	M	62	-	Farmer
81	James	M	83	Primary 6	Pensioner
82	Cecelia	F	61	LCE	Pensioner
83	Jeffry	M	57	STPM	Cleark
84	Tama	M	73	-	Farmer
85	Mary	F	70	-	Farmer
86	Liya	M	53	SRP	Pensioner
87	Sufri	F	44	SPM	Housewife
88	Roselin	M	51	SRP	Labourer
89	Julita	F	48	Primary 6	Farmer
90	Desoh	M	45	SRP	Labourer
91	Kori	F	46	SPM	Housewife
92	Edwin	M	48	SRP	Labourer
93	Marta	F	45	UPSR	Waitress
94	Luty	F	92	-	Farmer
95	Jusun	M	68	-	Farmer
96	Sueph	M	58	LCE	Labourer

97	Lily	F	56	LCE	Farmer
98	Siman	M	71	-	Farmer
99	Biham	F	73	-	Farmer
100	William	M	51	STPM	Supervisor
101	Lily	F	47	STPM	Housewife
102	Bless	M	50	SRP	Labourer
103	Eliza	F	48	-	Housewife
104	Abya	F	46	STPM	Custom officer
105	James	M	53	-	Pensioner
106	Freda	F	48	-	Housewife
107	Lawrence	M	57	-	Driver Assistant
108	Chandra	F	44	-	Housewife
109	Wenndy	F	57	-	Housewife
110	Mulok	M	62	LCE	Farmer
111	Segud	F	55	Primary 6	Farmer
112	Rose	F	38	SPM	Cleark
113	Tracy	F	35	SRP	Army
114	Naes	M	52	SRP	Farmer
115	Catherine	F	47	-	Farmer
116	Achau	M	72	-	Farmer

117	Jara	F	73	-	Farmer
118	Francis	M	52	Primary 6	Labourer
119	Buch	M	42	-	Labourer
120	Bunja	M	76	-	Farmer
121	Dain	F	74	-	Farmer
122	Roland	M	59	SPM	Labourer
123	Benota	F	53	SPM	Cleark
124	Mose	M	50	SRP	Pensioner
125	Elsi	F	48	Primary 6	Housewife
126	Nyagun	F	70		Farmer
127	Christopher	M	44	SPM	Store keeper
128	Emma	F	38	UPSR	Housewife
129	Lislin	F	37	SPM	Housewife
130	Brusely	M	50	SRP	Pensioner
131	Angela	F	48	SRP	Housewife
132	Musa	M	70	-	Farmer
133	Dana	F	69	-	Farmer
134	Linda	F	43	-	Farmer
135	Judy	F	46	SPM	Nurses
136	Shuzan	F	40	Master	Teacher

137	Makos	M	56	SPM	Field staff SALCRA
138	Inchap	F	78	-	Housewife
139	Elen	F	58	Degree	Teacher
140	Ricky	M	55	SPM	Health
141	Peter	M	53	SPM	Field staff SALCRA
142	Susie	F	53	SPM	Housewife
143	Rati	F	88	-	Farmer
144	John	M	52	SPM	Labourer
145	Ronnie	F	48	SPM	Farmer
146	Jeweh	M	53	-	Farmer
147	Jurem	F	50	-	Farmer
148	Alieu ak Dris	M	56	LCE	Labourer
149	Winnie	F	49	STPM	Farmer
150	Juman	F	71	-	Housewife
151	Dennis	M	54	SRP	Labourer
152	Arland	M	38	SPM	Cleark
153	Robert	M	61	Primary 6	Farmer
154	Rita	F	59	SRP	Farmer

155	Nair	F	70	-	Farmer
156	Helen	F	54	Primary 6	Nanny
157	Sylvia	F	61	Primary 6	Farmer
158	Palu	M	70	-	Farmer
159	Tungal	F	67	-	Farmer
160	Robert	M	53	SPM	Pensioner
161	Luneh	F	56	SRP	Housewife
162	John Achu	M	65	Master	Pensioner
163	Connie	F	61	LCE	Housewife
164	Bryan	M	41	Diploma	Cleark
165	George	M	57	SPM	Labourer
166	Farida	F	51	SPM	Farmer
167	Erene	F	50	SRP	Farmer
168	Sarun	F	71	-	Farmer
169	Julung	M	79	Primary 4	Farmer
170	Dino	F	76	-	Farmer
171	Salli	M	57	SPM	Cleark
172	Sanu	M	51	SPVM	Mechanic
173	Esther	F	44	SRP	Housewife
174	Jabo	M	61	SPVM	Pensioner

175	Liyu	F	84	-	Farmer
176	John	M	63	Primary 6	Farmer
177	Siriha	F	55	-	Cleaner
178	Mathew	M	53	SPM	Driver
179	Sino	F	59	LCE	Housewife
180	Risa	M	71	-	Farmer
181	Kiyung	F	64	-	Farmer
182	Josephine	F	53		Farmer
183	Lyidis	F	62	-	Farmer
184	Diana	F	40	-	Farmer
185	Christina	F	42	-	Labourer
186	Domy	M	45	-	Labourer
187	Allisa	F	41	-	Housewife
188	Friendson	M	44	-	Labourer
189	Rakok	F	67	-	Farmer
190	Colin	M	49	SRP	Driver
191	Emelda	F	40	SRP	Housewife
192	Jada	M	63	-	Labourer
193	Margaret	F	66	-	Farmer
194	Rine	F	68	-	Farmer

195	Deru	F			Farmer
196	Fiona	F	51	SRP	Farmer
197	Joseline	F	59	SRP	Farmer
198	Ritum	F	60	-	Farmer
199	Chunda	M	63	-	Labourer
200	Riri	F	58	-	Housewife
201	Cherang	M	53	SPM	Labourer
202	Jeff	M	37	SPM	Driver
203	Lydia	F	41	SPM	Housewife
204	Sylvester	M	39	SRP	Labourer
205	Korai	F	39	SPM	Housewife
206	Viktor	M	51	Primary	Farmer
207	Betsie	F	49	SPM	Farmer
208	Fredrick	M	59		Farmer
209	Chalis	F	57		Farmer
210	Sudin	M	64	Primary 6	Farmer
211	Rama	F	59	-	Farmer
212	Amelia	F	41		Cleark
213	Puga	M	61	LCE	Farmer
214	Felly	F	61		Farmer

215	Joseph	M	52	UPSR	Farmer
216	Willena	F	49	SRP	Farmer
217	Raphael	M	46	SRP	Labourer
218	Nyanis	F	84	-	Farmer
219	Ratine	F	68	-	Farmer
220	Nyambang	F	65	-	Farmer
221	Nora	F	41	PMR	Housewife
222	Langgut	M	75		Farmer
223	Josephine	F	51	SRP	Cleark
224	Mulia	F	46		Farmer
225	Dunstan	M	52	SPM	Labourer
226	Moni	F	44	Primary 6	Farmer
227	Rajak	M	55	Primary 6	Labourer
228	Mega	F	50	SRP	Farmer
229	Bunga	F	64	-	Farmer
230	Edmund	M	42	SRP	Army
231	Marian	F	42	SRP	Army
232	Empor	M	67	LCE	Pensioner
233	Saripah	F	57	LCE	Housewife
234	Christina	F	57	LCE	Housewife

235	Julie	F	68	Diploma	Pensioner
236	Talep	M	62	Primary 2	Farmer
237	Ayeng	F	80	-	Farmer
238	Runyam	F	70	Primary 1	Farmer
239	Bibi	F	66	Adult class	Farmer
240	Aban	M	71	-	Farmer
241	Karing	M	69	-	Farmer
242	Malei	M	82	-	Farmer
243	Niyum	F	77	-	Farmer
244	Sayum	F	74	-	Farmer
245	Richiok	M	79	-	Farmer
246	Landut	M	78	-	Farmer
247	Gadoh	F	74	-	Farmer
248	Tambong	M	80	-	Farmer
249	Sanyam	M	74	Primary 3	Farmer
250	Taub	M	73	Primary 5	Farmer
251	Sidoi	F	82	-	Farmer
252	Sulok	F	75	-	Farmer
253	Cicilia	F	55	Primary 6	Farmer
254	Sunggut	F	77	-	Farmer

255	Dawit	M	71	Primary 5	Farmer
256	Bibiana	F	45	Form 3	Farmer
257	Runai	F	58	Primary 2	Farmer
258	Gumbek	M	76	Primary 4	Farmer
259	Unyiaw	M	84	-	Farmer
260	Magdalene	F	62	-	Farmer
261	Jumer	M	73	-	Farmer
262	Kelei	M	66	-	Farmer
263	Ganyam	F	66	Primary 1	Farmer
264	Jampung	F	46	-	Farmer
265	Dundong	M	72	Primary 3	Retired (JKR)
266	Kalin	F	64	Primary 3	Housewife
267	Paon	F	58	Primary 5	Housewife
268	Dorokas @ Dorcas	F	69	Primary 3	Housewife

Appendix 3: The script interview of one of respondent

Kpg Murud Plaman

Date: 09.02.2016

Specimen no	Native name	Habit (Tree/herb/shrub /climber/...)	Part used	Disease treated	Mode of administration
001	Re-ahug	Shrub (Uduh antap)	Shoot (sisok)	Diarrhea (cirit)	Heat, crush and paste on stomach (Balar/panggang, kipel da naih)
002	Se-regu (sungu rigu)	Herb (kayuh iped)	Leaves (dawe)	Diarrhea (cirit)	Heat, crush and paste on stomach (Balar/panggang, kipel da naih)
003	Baid	Climber (kukah)	Leaves (dawe)	Wound (atang)	Chew and paste on wound (numpa kipel da atang)
004	Risek	Herb (kayuh iped)	Leaves (dawe)	Wound (atang)	Chew and paste on wound (numpa kipel da atang)
				Gastric (tugal)	Chew and paste on chest (numpa kipel da adeg)
				Toothhache (Mandam jipeh)	Boil, water for gargle (Tanek, umo tinan kumuk)
005	Jaring	Tree (Bikayuh)	Leaves (dawe)	Blotted stomach (naih birangin)	Heat, crush and paste on stomach (Balar/panggang, kipel da naih)
006	Buru pangen	Climber (kukah)	Leaves (dawe)	Stomachache (mandam naih) Wound (atang)	Heat, crush and paste on stomach (Balar/panggang, kipel da naih) Heat, crush and paste on wound (Balar/panggang, kipel da atang)
007	Atap batuh	Tree (Bikayuh)	Leaves (dawe)	Vomiting (bilogog)	Heat, crush and paste on stomach (Balar/panggang, kipel da naih)
008	Buan	Tree (Bikayuh)	Leaves (dawe)	Vomiting (bilogog)	Heat, crush and paste on stomach (Balar/panggang, kipel da naih)

009	Simukau	Tree/herb (kayuh dipeh)	Leaves (dawe)	Sore eyes (bateh bidaya)	Crushed and squeezed on eyes (kusuk, umo kudog da bateh)
010	Kiabeg	Tree (Bikayuh)	Leaves (dawe)	Stomachache (mandam naih)	Boil and drink (rabus, umo sihup)
011	Kunyit	Shrub (Uduh antap)	Leaves (dawe)	Diarrhea (cirit)	Heat, crush and paste on stomach (Balar/panggang, kipel da naih)
012	Tamu	Shrub (Uduh antap)	Leaves (dawe)	Diarrhea (cirit)	Heat, crush and paste on stomach (Balar/panggang, kipel da naih)
013	Gilingang	Herb (kayuh iped)	Root (uhat)	Blotted stomach (naih birangin)	Crush and tie on stomach (Kusuk, kipel da naih)
014	Bahai	Herb (kayuh iped)	Root (Uhat) Fruit (ati bahai)	Blotted stomach (naih birangin) Toothache Mandam jipeh)	Crush and tie on stomach (Kusuk, kipel da naih) Chew (numpa)
015	Kudu	Tree (Bikayuh)	Young fruit (Bua diped) shoot (sisok)	High blood pressure (daya gatuh)	As salad (tunan pane)
016	Tibereh (dadiped)	Shrub (Uduh antap)	Leaves (dawe)	Skin itching	Boil and for bath (Rabus, tinan mamuh)
017	Chuah	Tree (Bikayuh)	Leaves (dawe)	Confinement (kandam biranak)	Boil and for bath (Rabus, tinan mamuh)
				Stomachache	Heat and paste on stomach (balar@ pandee, kipel da naih)
018	Kareh	Herb (kayuh iped)	Cabbage (umud)	Snake bite (patuk nyipeh)	Tutok, sapu
019	Uduh antap	Herb (kayuh iped)	Cabbage (umud) leaves (dawe)	Stomachache Stomachache (mandam naih)	Chew and drink (Gigit2, umo teren) Heat and paste on stomach (Balar/panggang, kipel da naih)
020	Bingale	Herb (kayuh iped)	Cabbage (umud)	Body pain (tibu pagal-pagal),	Heat, rub with coconut oil and paste on pain area

				swelling(bangkak) (, sprains (mandam urat)	(Balar, sapu inyo buntan kipel da tempat mandam
021	Buru	Herb (kayuh iped)	Tree (Kayuh)	Skin itching (kulit tihi)	Heat and rub at itchi skin (Balar, naleg2x da tempat tihi)
021	Dihan	Tree (Bikayuh)	Fruit skin (Kulit bua)	Boils (pirangkis)	Heat and paste on boi[s (Bade, kipel)
022	Pidengen	Shrub (Uduh antap)	Young shoot (Pakuh ungon)	Boils (pirangkis)	Crush and paste on boils (tutok, kipel)
023	Pakuh sibuk	Shrub (Uduh antap)	Young shoot (Pakuh ungon)	Confinement (kanam biranak) less breastmilk (kurang susu)	Tutok, kipel da susu
024	Milambe	Tree (Bikayuh)	Young leave (sisok)	Swelling (bangkak/ kamang)	Heat and paste on swelling area (Panggang, kipel)
025	Kukah pireged	Climber (kukah)	Whole plant (Simua bigian)	Painful bladder (mandam sarang kasing)	Boil and drink (Rabus, minuh ai)
026	Taang	Tree (Bikayuh)	Bark (kupak)	Spleen pain (mandam urat)	Heat , crush and rub with coconut oil and paste on pain area (Panggang, tutok, sapu myk kelapa, kipel da naih)
027	Bilanda	Tree (Bikayuh)	Fruit, leaves (Buah, Bua, dawe)	High blood pressure (daya gatuh)	As salad (Nulam)
028	Langir	Tree (Bikayuh)	Fruit skin (Kulit bua)	Dandruff (biklimumur)	As syampoo (Tinan syampoo)
029	Kukah nya-nyat	Climber (kukah)	Whole plant (semua bigian)	Blotted stomach (naih birangin)	Heat, rub with coconut oi; and paste on stomach (Pandee, naleg inyo buntan, kipel da naih.)
030	Kiruang	Tree (Bikayuh)	Leaves	Scabis (bikudis)	Chew and paste on scabis

			(dawe)		(Numpa dawe, kipel da kudis)
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Respondent: Bibi ak Jupau (F) Age: 66 yrs

Appendix 4: List of Medicinal Plants by Bidayuh Community in Serian

	Family	Species	Vernacular name
1.	Acanthaceae	<i>Clinacanthus nutans</i> (Burm. f.) Lindau	Kayap, Belalai gajah
2.	Acanthaceae	<i>Justicia gendarrusa</i> Burm. f.	Miting
3.	Acoraceae	<i>Acorus calamus</i> L.	Jerangau
4.	Actinidiaceae	<i>Saurauia</i> sp.	Simumpod
5.	Annonaceae	<i>Annona muricata</i> L.	Nangka bilana
6.	Annonaceae	<i>Goniothalamus dolichocarpus</i> Merr.	Rayan
7.	Annonaceae	<i>Goniothalamus uvaroides</i> King	Palis
8.	Annonaceae	<i>Phaenthus splendens</i> Miq.	Simukau
9.	Annonaceae	<i>Polyalthia lapadantha</i> Diels.	Sinaai
10.	Annonaceae	<i>Popowia</i> sp.	Kimpang taha
11.	Araceae	<i>Aglaonema simplex</i> (Bl.) Bl.	Kibang taruh
12.	Araceae	<i>Alocasia beccarii</i> Engl.	Gamba
13.	Araceae	<i>Alocasia longiloba</i> Miq.	Keladi Birah
14.	Araceae	<i>Bucephalandra mottleyana</i> Schott.	Kakah Pilanuk
15.	Araceae	<i>Homalomena propinqua</i> Schott	Tingon Aud
16.	Araceae	<i>Homalomena sagittaria</i> Jungh ex Schott.	Tungan daya
17.	Araceae	<i>Phytos scandens</i> L.	Sinimpang
18.	Arecaceae	<i>Areca catechu</i> L.	Bahai
19.	Arecaceae	<i>Cocos nucifera</i> L.	Butan
20.	Arecaceae	<i>Metroxylon sagu</i> Rottb.	Sago
21.	Arecaceae	<i>Eleiodoxa conferta</i> (Becc.) Burret	Angkab
22.	Arecaceae	<i>Plectocomiopsis mira</i> J. Dransf.	Umud lalih

23.	Apocynaceae	<i>Alstonia angustiloba</i> Miq.	Gente
24.	Apocynaceae	<i>Allamanda cathartica</i> L.	Bunga allamanda
25.	Apocynaceae	<i>Hoya</i> sp.	Makah pait
26.	Araliaceae	<i>Schefflera petiolosa</i> Harms.	Perlina
27.	Araliaceae	<i>Trevesia burckii</i> Boerl.	Kruang Davod
28.	Asperagaceae	<i>Cordyline fruticosa</i> (L.) A. Chev.	Prugat
29.	Asteraceae	<i>Ageratum conyzoides</i> (L.) L.	Uduh sekeh
30.	Asteraceae	<i>Blumea balsamifera</i> (L.) DC.	Chuah
31.	Asteraceae	<i>Chomolaena odorata</i> (L.) R.M. King & H. Rob.	Jambi
32.	Asphodelaceae	<i>Aloe vera</i> (L.) Burm. f.	Lidah buai
33.	Amaryllidaceae	<i>Allium cepa</i> var. <i>aggregatum</i>	Bawang bidaya
34.	Blechnaceae	<i>Blechnum orientale</i> (L.) C. Presl.	Pidengen
35.	Caricaceae	<i>Carica papaya</i> L.	Sulur
36.	Clusiaceae	<i>Garcinia mangostana</i> L.	Sikok
37.	Clusiaceae	<i>Gracinia xanthochymus</i> Hook.f ex T. Anderson	Kanes
38.	Commelinaceae	<i>Amischotolype</i> sp.	Pingkalan burus
39.	Convolvulaceae	<i>Ipomea aquatica</i> Forssk.	Kat Miniet
40.	Convolvulaceae	<i>Ipomoea batatas</i> (L.) Lam.	Tele
41.	Convolvulaceae	<i>Merromia</i> sp.	Kukah nya-nyat
42.	Crassullaceae	<i>Kalachoe pinnata</i> (Lam.) Pers.	Pingkudip
43.	Cucurbitaceae	<i>Momordica charantia</i> L.	Keria
44.	Cyperaceae	<i>Cyperus</i> sp.	Tabat
45.	Dilleniaceae	<i>Dillenia suffruticosa</i> (Griff.) Mart.	Buan

46.	Euphorbiaceae	<i>Macaranga tanarius</i> (L.) Muell.-Arg.	Purang
47.	Euphorbiaceae	<i>Manihot esculenta</i> Crantz	Ubi kayu
48.	Fabaceae	<i>Albizia saponaria</i> (Lour.) Bl. ex Miq.	Langir
49.	Fabaceae	<i>Archidendron clypearia</i> (Jack) Nielson	Triputi
50.	Fabaceae	<i>Archidendron jiringa</i> (Jack) Nielsen	Jaring
51.	Fabaceae	<i>Derris elliptica</i> (Wall.) Benth.	Tibuhat
52.	Fabaceae	<i>Desmodium capitatum</i> (Burm. f.) DC.	Dendam
53.	Fabaceae	<i>Mimosa pudica</i> L.	Uduh maya
54.	Fabaceae	<i>Mucuna biplicata</i> Teijsm. & Binn ex Kurz.	Brading Merading
55.	Fabaceae	<i>Senna alata</i> (L.) Roxb.	Gilingang
56.	Gesneriaceae	<i>Cyrtandra</i> sp.	Kumpang bumbo
57.	Lamiaceae	<i>Callicarpa</i> sp.	Bancing
58.	Lamiaceae	<i>Ocimum basilicum</i> L.	Gete
59.	Lamiaceae	<i>Vitex pinnata</i> L.	Meruat
60.	Lauraceae	<i>Cinnamomum</i> sp.	Abos
61.	Lauraceae	<i>Litsea elliptica</i> Bl.	Ayew, Ayau
62.	Lauraceae	<i>Litsea garciae</i> Vidal	Ta'ang
63.	Lauraceae	<i>Eusideroxylon zwageri</i> Teijsm. & Binn.	Tahas
64.	Lycopodiaceae	<i>Palhinhaea cernua</i> (L.) Vasc. & Franco	Seregu
65.	Malvaceae	<i>Abelmoschus esculentus</i> (L.) Moench.	Kacang lender
66.	Malvaceae	<i>Durio ziberthinus</i> L.	Dihan
67.	Malvaceae	<i>Hibiscus rosa-sinensis</i> L.	Bunga kamang
68.	Malvaceae	<i>Sterculia</i> sp.	Pingkudip dihan

69.	Marantaceae	<i>Donax canniformis</i> (G. Forster) K. Schum.	Bamban
70.	Melastomataceae	<i>Melastoma affine</i> D. Don	Risek
71.	Meliaceae	<i>Lansium parasiticum</i> (Osbeck) Sahn & Bennet	Lase
72.	Meliaceae	<i>Sandoricum</i> sp.	Kaaded asem
73.	Moraceae	<i>Artocarpus elasticus</i> Reinw. ex Bl.	Mayuh
74.	Moraceae	<i>Artocarpus heterophyllus</i> Lam.	Nangka
75.	Moraceae	<i>Ficus</i> sp.	Entagen
76.	Musaceae	<i>Musa balbisiana</i> Colla	Barak padi
77.	Musaceae	<i>Musa paradisiaca</i> L.	Barak
78.	Myrsinaceae	<i>Myrsine</i> sp.	Kamang pisu
79.	Myrtaceae	<i>Psidium guajava</i> L.	Kiabeg
80.	Nephrolepidaceae	<i>Nephrolepis biserrata</i> (Sw.) Schott.	Paku sibok
81.	Orchidaceae	<i>Dendrobium crumenatum</i> Sw.	Sarang kimpung
82.	Oxalidaceae	<i>Averrhoa bilimbi</i> L.	Girinang, Mirinang
83.	Phyllanthaceae	<i>Baccaurea motleyana</i> Mull.-Arg.	Milambe
84.	Phyllanthaceae	<i>Sauropus androgynous</i> (L.) Merr.	Cangkok manis
85.	Phyllanthaceae	<i>Phyllanthus niruri</i> L.	Uduh injes
86.	Piperaceae	<i>Piper betle</i> L.	Baid
87.	Piperaceae	<i>Piper caninum</i> Bl.	Baid babi
88.	Piperaceae	<i>Piper nigrum</i> L.	Lada hitam
89.	Piperaceae	<i>Piper porphyrophyllum</i> N.E. Br.	Lada tarun
90.	Piperaceae	<i>Piper sarmentosum</i> Roxb. ex Hunter	Kriih, Kaduh riih
91.	Poaceae	<i>Bambusa</i> sp.	Buluh

92.	Poaceae	<i>Cymbopogon nardus</i> (L.) Rendle	Bunga serai
93.	Poaceae	<i>Dendrocalamus asper</i> (Schult.) Baker	Buru
94.	Poaceae	<i>Imperata cylindrica</i> (L.) Raeusch. & P. Beauv.	Pade, Pide
95.	Poaceae	<i>Oryza glutinosa</i> L.	Bare pulut
96.	Poaceae	<i>Oryza sativa</i> L.	Bare
97.	Poaceae	<i>Paspalum conjugatum</i> P.J. Berguis	Kumpai
98.	Poaceae	<i>Penisetum</i> sp.	Tiha lambe
99.	Poaceae	<i>Saccharum officinarum</i> L.	Tabuh
100.	Psilotaceae	<i>Psilotum complanatum</i> Sw.	Sankam bateh aduh
101.	Rosaceae	<i>Rubus moluccanus</i> L.	Kare
102.	Rubiaceae	<i>Morinda citrifolia</i> L.	Kudu
103.	Rubiaceae	<i>Nauclea</i> sp.	Bangkel
104.	Rubiaceae	<i>Pavetta</i> sp.	Anyah
105.	Rubiaceae	<i>Pilea</i> sp.	Sapang entek, Tibaan
106.	Rubiaceae	<i>Spermacoce alata</i> Aubl.	Bukuh
107.	Rubiaceae	<i>Uncaria gambir</i> (Hunter) Roxb.	Gambi
108.	Rutaceae	<i>Citrus hystrix</i> DC.	Limau purut
109.	Rutaceae	<i>Citrus aurantifolia</i> (Chrism.) Swingle	Limau nipis
110.	Rutaceae	<i>Citrus microcarpa</i> (Bunge) Wijnands	Limau kesturi
111.	Rutaceae	<i>Citrus limon</i> (L.) Osbeck	Limon
112.	Schizaeaceae	<i>Lygodium circinatum</i> (Burm. f.) Sw.	Kukah pireged
113.	Solanaceae	<i>Physalis peruviana</i>	Ratup, Rutok
114.	Simaroubaceae	<i>Eurycoma longifolia</i> Jack	Tangkat ali
115.	Thymelaeaceae	<i>Phaleria macrocarpa</i> Boerl.	Mahkota dewa

116.	Vitaceae	<i>Leea indica</i> (Burm. f.) Merr.	Kiruang
117.	Zingiberaceae	<i>Alpinia galanga</i> (L.) Willd.	Lengkuas
118.	Zingiberaceae	<i>Alpinia purpurata</i> K. Schum.	Laih andang
119.	Zingiberaceae	<i>Curcuma longa</i> L.	Siew, Kunyit, Siyu
120.	Zingiberaceae	<i>Curcuma xanthorrhiza</i> Roxb.	Tamu, Tomot
121.	Zingiberaceae	<i>Curcuma zedoria</i> (Christm.) Roscoe	Tamu
122.	Zingiberaceae	<i>Etingera elatior</i> (Jack) R.M. Sm.	Ngkreh
123.	Zingiberaceae	<i>Kaempferia galanga</i> L.	Sakur
124.	Zingiberaceae	<i>Zingiber spectabile</i> Griff.	Tipuu
125.	Zingiberaceae	<i>Zingiber officinale</i> Roscoe	Laih grane
126.	Zingiberaceae	<i>Zingiber ottensii</i> Valetton	Bingale

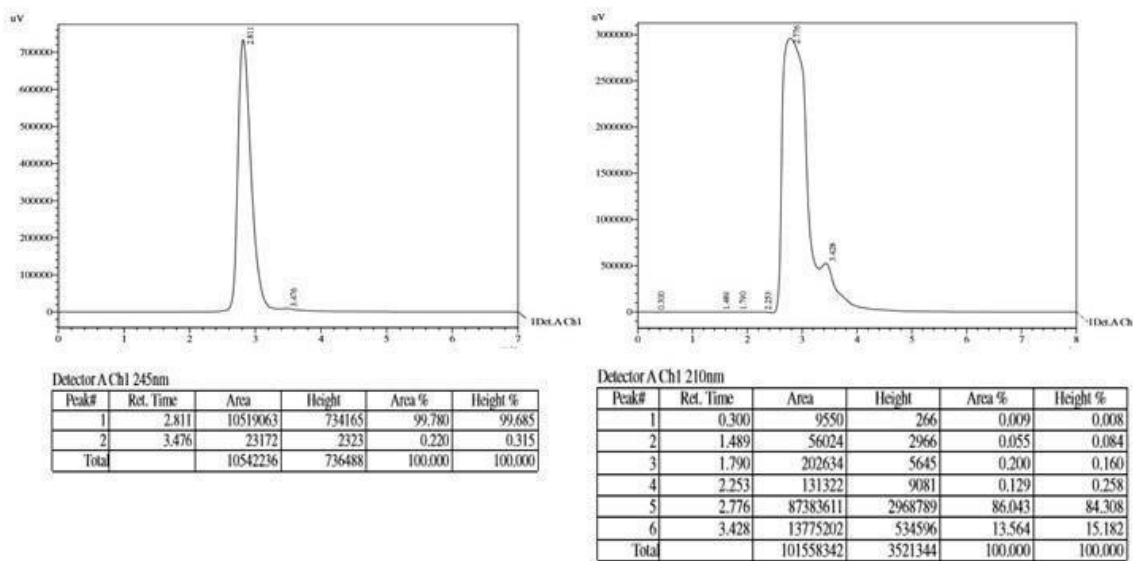
Appendix 5: Chemical Analysis of Bioactive Compounds in Some Selected Plants (summary)

	Species	Carvocrol		Phenol		Quinine		Thymol		Emodin	
		B	C	B	C	B	C	B	C	B	C
1.	<i>Piper betle</i>				√					√	√
2.	<i>Cucurma longa</i>				√					√	√
3.	<i>Blumea balsamifera</i>				√					√	√
4.	<i>Cucurma xanthorrhiza</i> (rhizome)				√					√	√
5.	<i>Cucurma xanthorrhiza</i> (leaves)				√			√		√	√
6.	<i>Kaempferia galanga</i>				√					√	√
7.	<i>Garcinia mangostana</i>				√					√	√
8.	<i>Cucurma zendorfia</i>									√	√
9.	<i>Piper porphyrophyllum</i>				√			√		√	√
10.	<i>Allium cepa</i>				√					√	√
11.	<i>Averrhoa bilimbi</i>				√					√	√
12.	<i>Physalis foetida</i>				√		√			√	√

13.	<i>Morinda citrifolia</i>	√	√	√	√	√
14.	<i>Oryza glutinosa</i>		√		√	√
15.	<i>Leea indica</i>		√		√	√
16.	<i>Vernonia arborea</i>	√	√		√	√
17.	<i>Trema cannabina</i>	√			√	
18.	<i>Senna alata</i>		√	√	√	√
19.	<i>Lindernia diffusa</i>		√		√	√
20.	<i>Citrus aurantifolia</i>		√	√	√	√

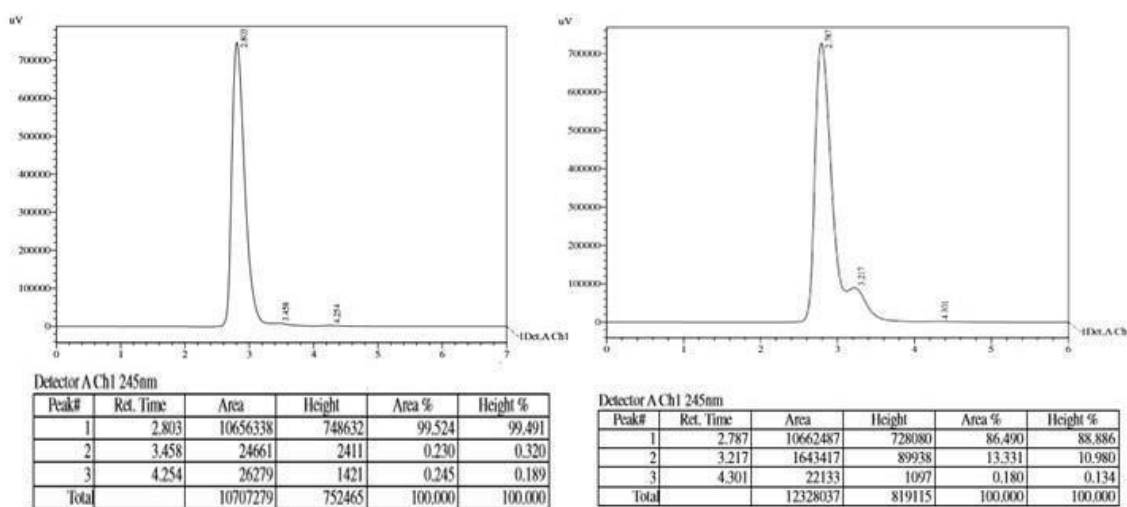
B: Solvent – Ethyl Acetate; C: Solvent – Dichloromethane

Appendix 6



Sample B1: *Piper betle*

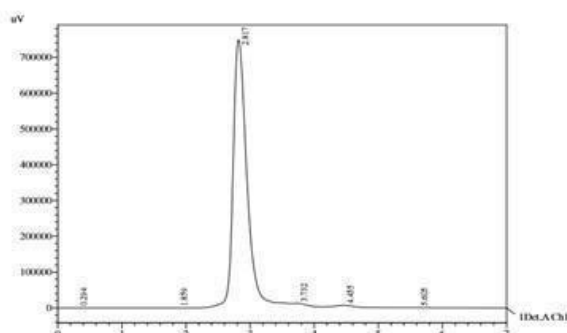
Sample B2: *Curcuma longa*



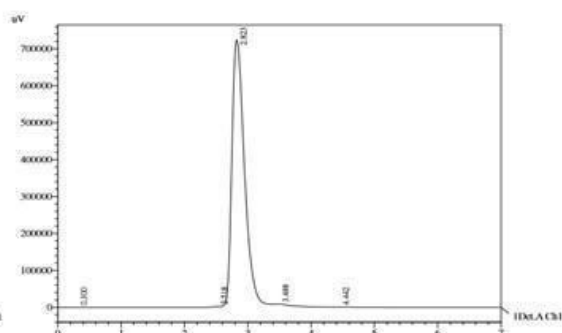
Sample B3: *Blumea balsamifera*

Sample B6: *Kaempferia galanga*

Figure 0.1: Selected bioactive compounds detected in the sample (soak in Dichloromethane); Sample B1, B2, B3 and B6



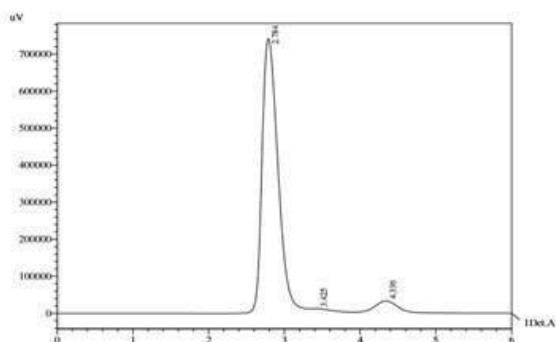
Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.294	3611	172	0.031	0.023
2	1.859	2825	153	0.024	0.020
3	2.817	11676779	748949	98.905	98.897
4	3.732	33014	2703	0.280	0.357
5	4.455	86837	5138	0.736	0.678
6	5.605	2932	184	0.025	0.024
Total		11805999	757298	100.000	100.000



Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.300	2196	100	0.021	0.014
2	2.518	19315	2413	0.187	0.331
3	2.823	10296281	724584	99.568	99.352
4	3.488	21132	2110	0.204	0.289
5	4.442	1994	99	0.019	0.014
Total		10340918	729307	100.000	100.000

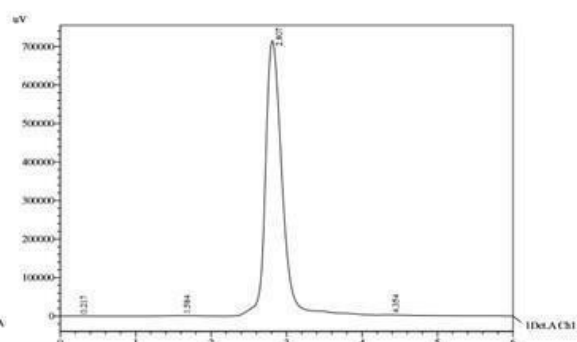
Sample B4: *Cucurma xanthorrhiza* (rhizome)

Sample B5: *Cucurma xanthorrhiza* (leaves)



Peak#	Ret. Time	Area	Height	Area %	Height %
1	2.784	11302106	741564	94.601	95.749
2	3.425	23482	1955	0.197	0.252
3	4.336	621604	30966	5.203	3.998
Total		11947193	774485	100.000	100.000

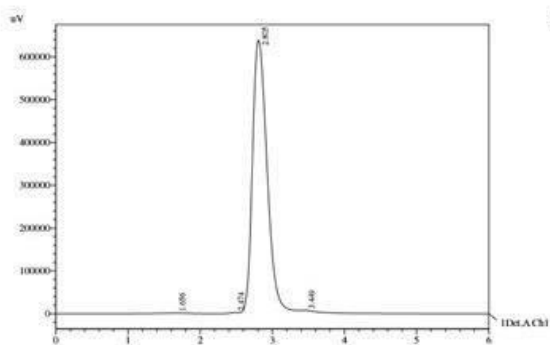
Sample B7: *Garcinia mangostana*



Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.217	2873	161	0.025	0.022
2	1.584	32398	966	0.287	0.135
3	2.807	11231960	715332	99.601	99.762
4	4.354	9738	583	0.086	0.081
Total		11276968	717042	100.000	100.000

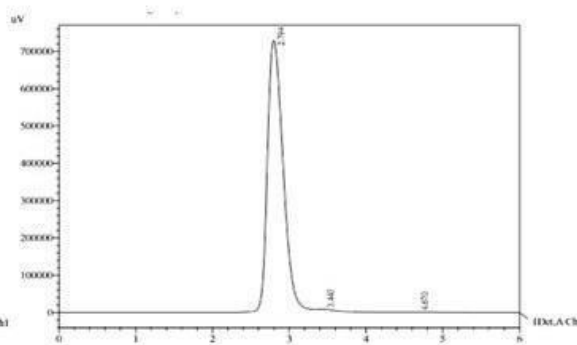
Sample B8: *Cucurma zendorfia*

Figure 0.2: Selected bioactive compounds detected in the sample (soak in Dichloromethane); Sample B4, B5, B7 and B8



Detector A Ch1 245nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	1.656	34864	1184	0.375	0.184
2	2.474	19858	2504	0.214	0.388
3	2.805	9225589	639800	99.263	99.226
4	3.449	13737	1299	0.148	0.202
Total		9294048	644788	100.000	100.000

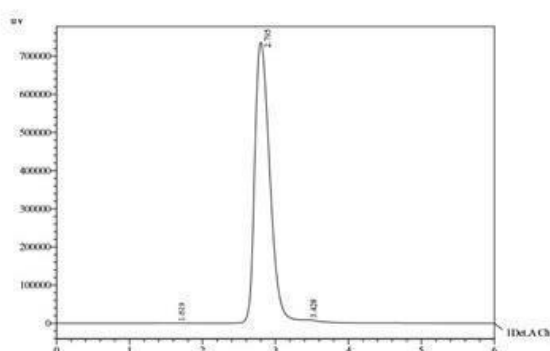


Detector A Ch1 245nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	2.794	10666224	729722	99.771	99.734
2	3.443	19443	1818	0.182	0.248
3	4.670	5020	130	0.047	0.018
Total		10690687	731669	100.000	100.000

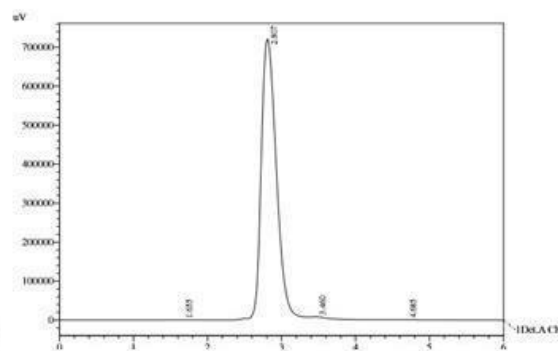
Sample B9: *Piper porphyrophyllum*

Sample B10: *Allium cepa*



Detector A Ch1 245nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	1.619	13808	464	0.128	0.063
2	2.795	10728762	736546	99.758	99.815
3	3.428	12181	904	0.113	0.123
Total		10754751	737914	100.000	100.000



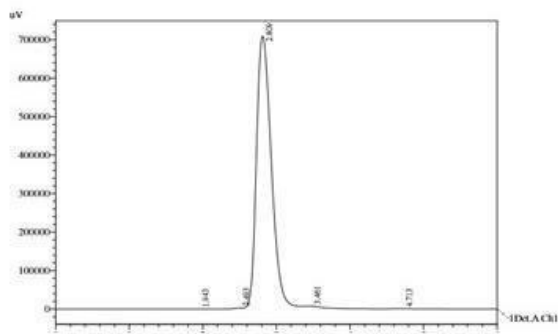
Detector A Ch1 245nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	1.655	13511	561	0.149	0.078
2	2.807	10392425	720788	99.633	99.662
3	3.460	18526	1775	0.178	0.245
4	4.685	4256	112	0.041	0.016
Total		10430718	723236	100.000	100.000

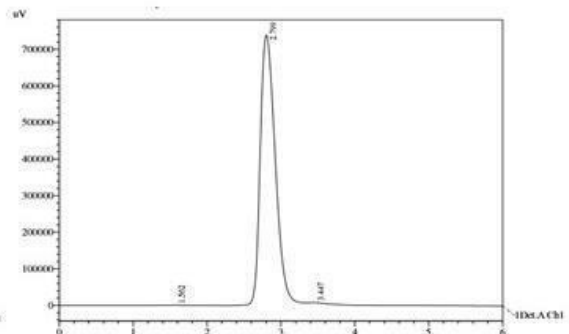
Sample B11: *Averrhoa bilimbi*

Sample B12: *Physalis foetida*

Figure 0.3: Selected bioactive compounds detected in the sample (soak in Dichloromethane); Sample B9, B10, B11 and B12



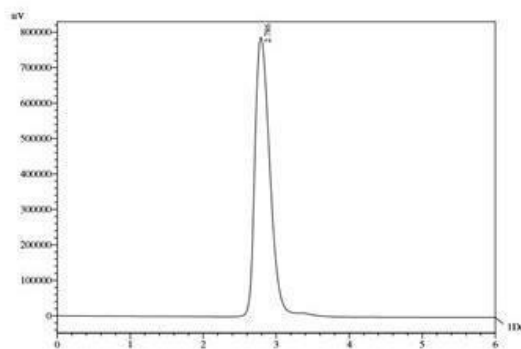
Peak#	Ret. Time	Area	Height	Area %	Height %
1	1.943	6423	199	0.063	0.028
2	2.493	22347	2783	0.219	0.389
3	2.809	10158758	709471	99.440	99.286
4	3.461	19109	1871	0.187	0.262
5	4.713	9301	250	0.091	0.035
Total		10215938	714574	100.000	100.000



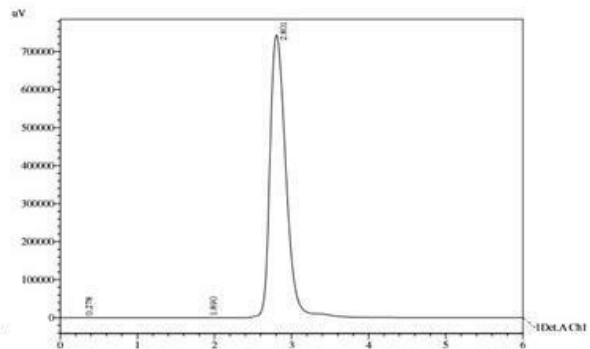
Peak#	Ret. Time	Area	Height	Area %	Height %
1	1.562	22497	745	0.211	0.100
2	2.799	10628928	739256	99.560	99.616
3	3.447	24453	2102	0.229	0.283
Total		10675878	742103	100.000	100.000

Sample B13: *Morinda citrifolia*

Sample B14: *Oryza glutinosa*



Peak#	Ret. Time	Area	Height	Area %	Height %
1	2.786	11382446	788477	100.000	100.000
Total		11382446	788477	100.000	100.000

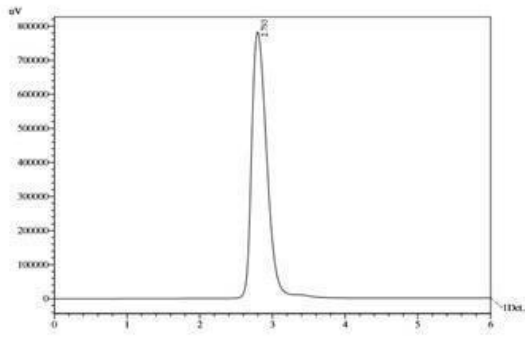


Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.278	6007	298	0.056	0.040
2	1.890	5154	166	0.048	0.022
3	2.801	10757707	743813	99.896	99.938
Total		10768868	744277	100.000	100.000

Sample B15: *Leea indica*

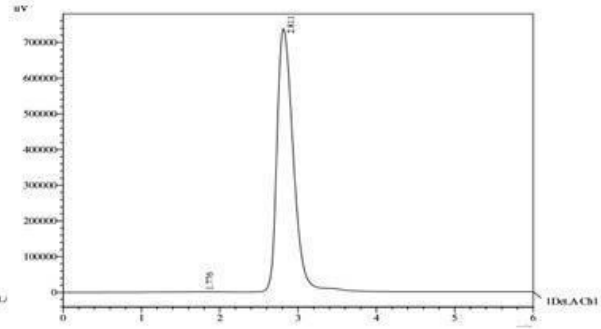
Sample B16: *Vernonia arborea*

Figure 0.4: Selected bioactive compounds detected in the sample (soak in Dichloromethane); Sample B13, B14, B15 and B16



Detector A Ch1 245nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	2.793	11397392	782084	100.000	100.000
Total		11397392	782084	100.000	100.000

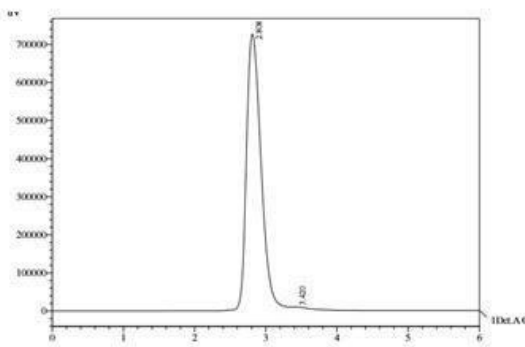


Detector A Ch1 245nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	1.776	43133	800	0.399	0.108
2	2.811	10775571	737576	99.601	99.892
Total		10818704	738375	100.000	100.000

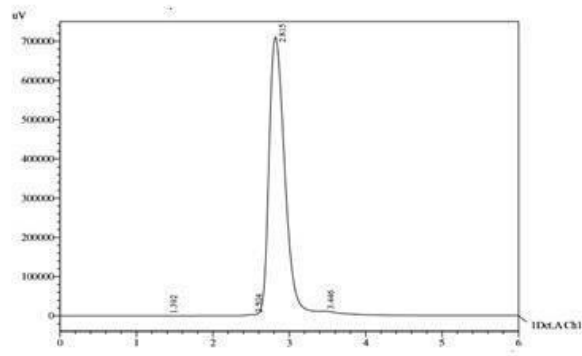
Sample B17: *Trema cannabina*

Sample B18: *Senna alata*



Detector A Ch1 245nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	2.808	10581312	726598	99.871	99.844
2	3.420	13707	1137	0.129	0.156
Total		10595019	727734	100.000	100.000



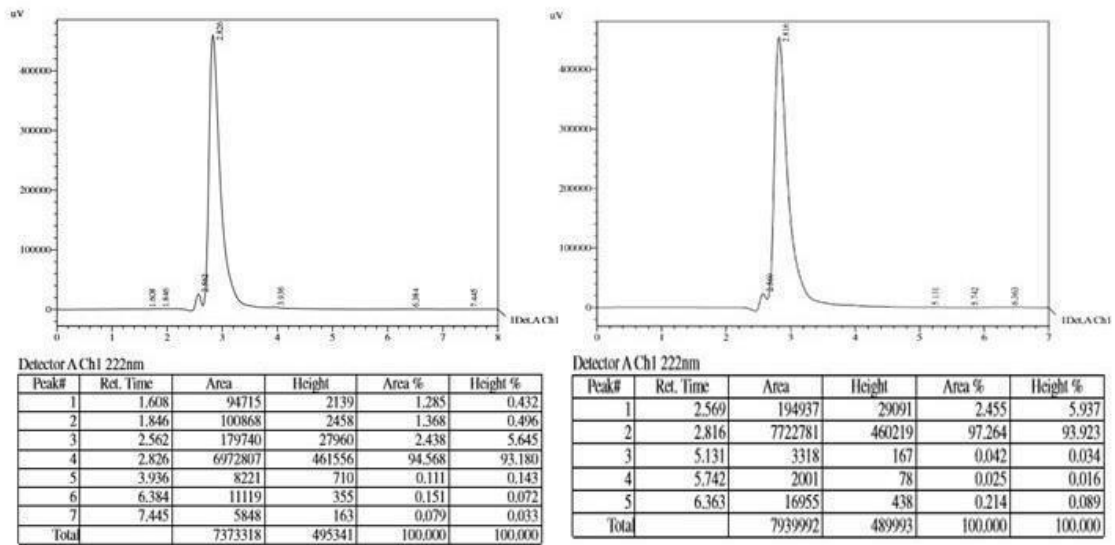
Detector A Ch1 245nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	1.392	1365	45	0.013	0.006
2	2.504	22419	2650	0.213	0.371
3	2.815	10473395	710458	99.626	99.438
4	3.446	15518	1317	0.148	0.184
Total		10512697	714471	100.000	100.000

Sample B19: *Lindernia diffusa*

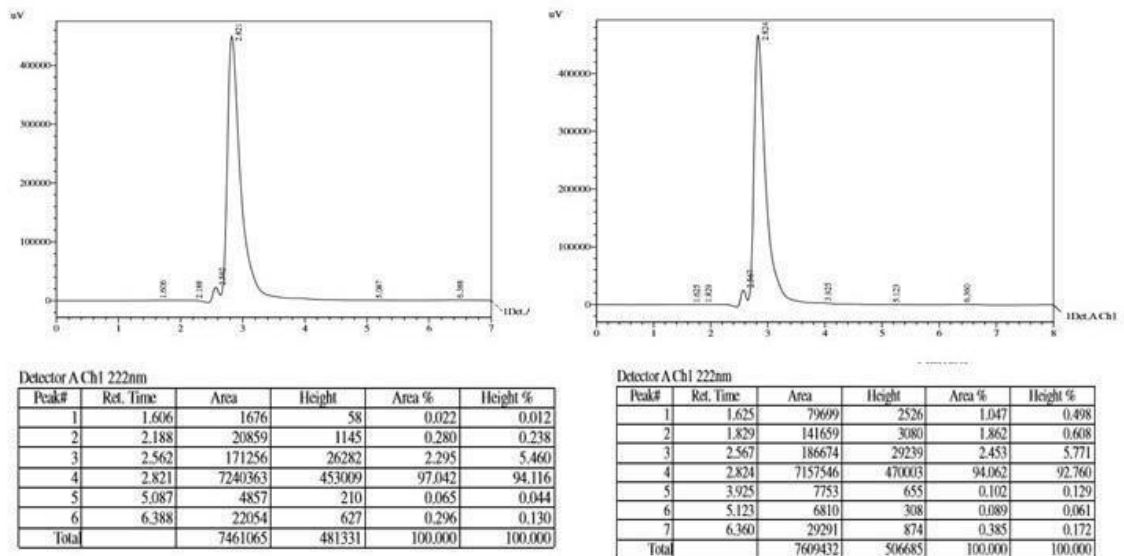
Sample B20: *Citrus aurantifolia*

Figure 0.5: Selected bioactive compounds detected in the sample (soak in Dichloromethane); Sample B17, B18, B19 and B20



Sample C1: *Piper betle*

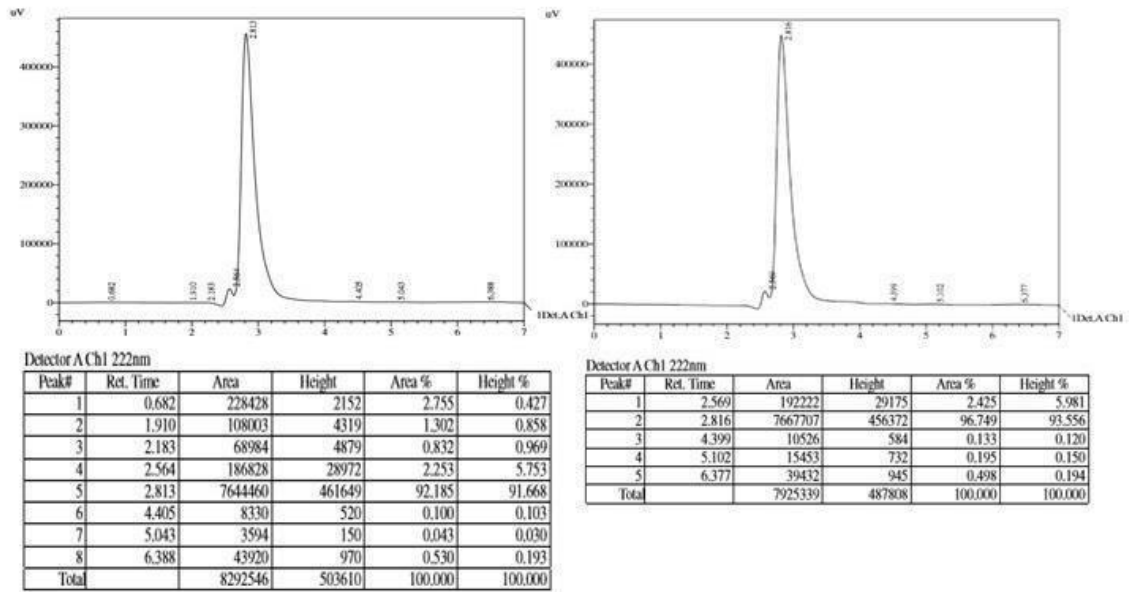
Sample C2: *Cucurma longa*



Sample C3: *Blumea balsamifera*

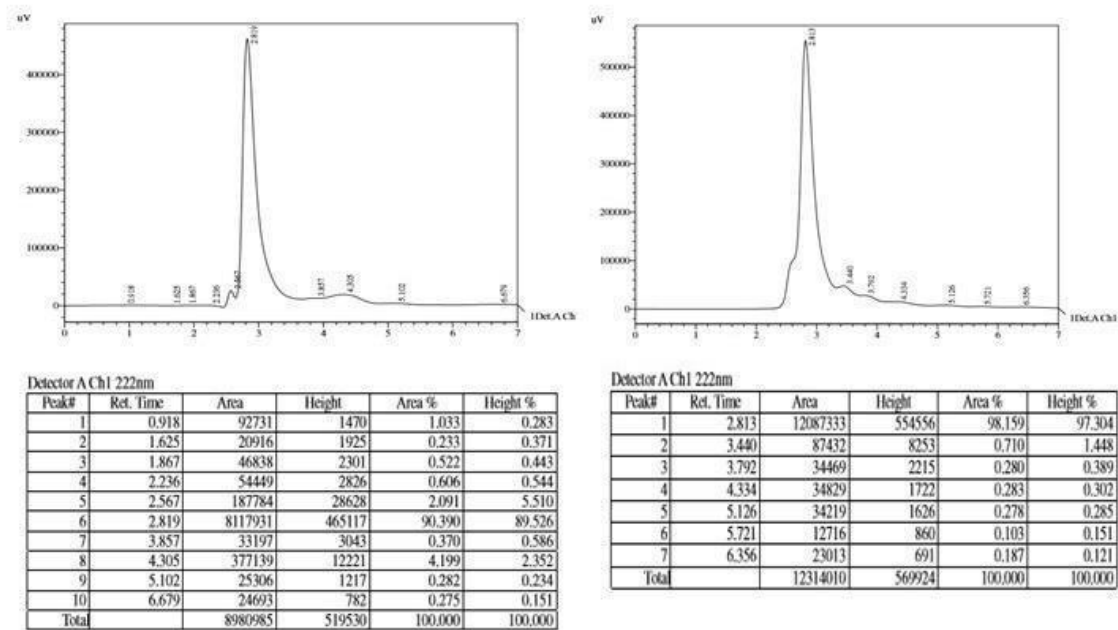
Sample C6: *Kaempferia galanga*

Figure 0.6: Selected bioactive compounds detected in the sample (soak in Dichloromethane); Sample C1, C2, C3 and C6



Sample C4: *Curcuma xanthorrhiza* (rhizome)

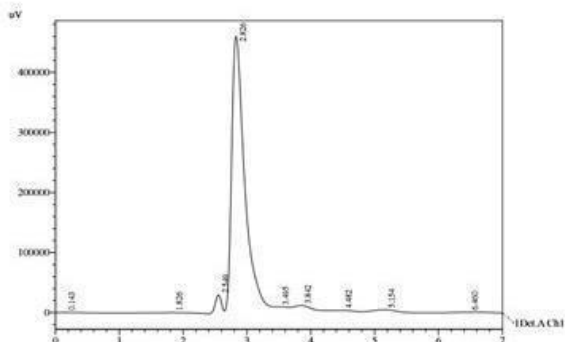
Sample C5: *Curcuma xanthorrhiza* (leaves)



Sample C7: *Garcinia mangostana*

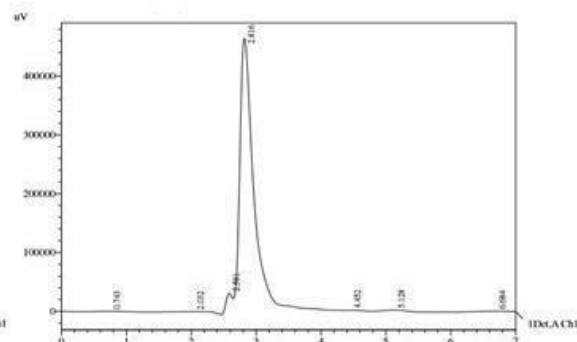
Sample C8: *Curcuma zedoria*

Figure 0.7: Selected bioactive compounds detected in the sample (soak in Dichloromethane); Sample C4, C5, C7 and C8



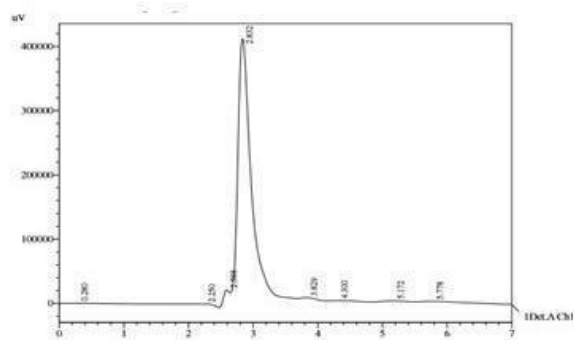
Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.143	6897	250	0.088	0.049
2	1.826	79661	1520	1.018	0.299
3	2.549	212863	31426	2.720	6.187
4	2.826	7287495	462193	93.125	90.993
5	3.495	9983	744	0.128	0.146
6	3.842	83008	5588	1.051	1.100
7	4.482	17907	1016	0.229	0.200
8	5.154	92652	4144	1.184	0.816
9	6.460	35061	1063	0.448	0.209
Total		7825528	507944	100.000	100.000

Sample C9: *Piper porphyrophyllum*



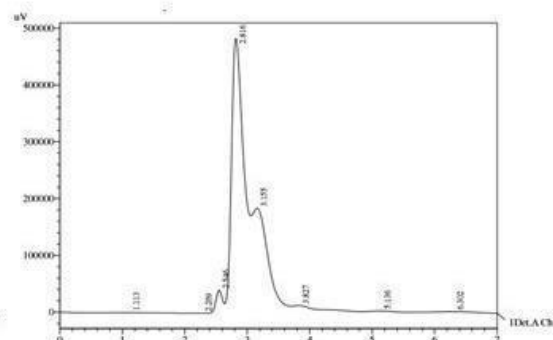
Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.743	31095	1075	0.381	0.209
2	2.032	150578	3297	1.847	0.641
3	2.581	249507	36156	3.061	7.033
4	2.816	7623656	469471	93.523	91.327
5	4.452	7610	388	0.093	0.075
6	5.128	63096	2816	0.774	0.548
7	6.684	26116	850	0.320	0.165
Total		8151657	514053	100.000	100.000

Sample C10: *Allium cepa*



Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.280	42177	905	0.530	0.198
2	2.250	38198	2296	0.480	0.502
3	2.588	184193	27295	2.316	5.969
4	2.832	7433276	418292	93.448	91.478
5	3.829	32685	2432	0.411	0.532
6	4.300	24463	798	0.308	0.175
7	5.172	66372	2511	0.834	0.549
8	5.778	133059	2731	1.673	0.597
Total		7954422	457262	100.000	100.000

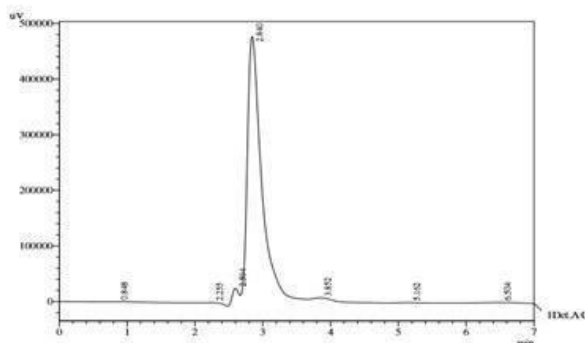
Sample C11: *Averrhoa bilimbi*



Peak#	Ret. Time	Area	Height	Area %	Height %
1	1.113	19646	659	0.176	0.092
2	2.269	1652	224	0.015	0.031
3	2.546	302404	40238	2.708	5.614
4	2.816	6686604	484026	59.869	67.533
5	3.155	3997952	184802	35.796	25.784
6	3.827	38805	3105	0.347	0.433
7	5.136	37130	1724	0.332	0.241
8	6.302	84619	1948	0.758	0.272
Total		11168812	716726	100.000	100.000

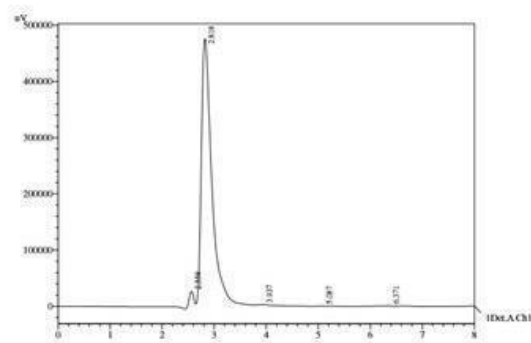
Sample C12: *Physalis foetida*

Figure 0.8: Selected bioactive compounds detected in the sample (soak in Dichloromethane); Sample C9, C10, C11 and C12



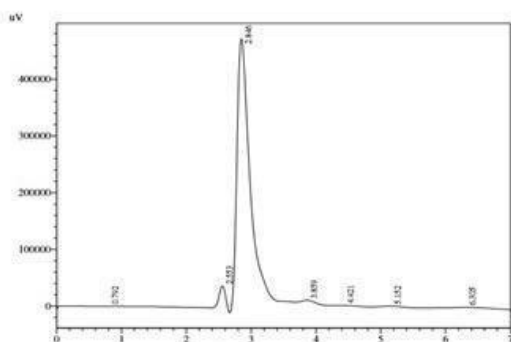
Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.848	11633	335	0.139	0.064
2	2.255	64120	3392	0.767	0.645
3	2.594	210001	31720	2.511	6.028
4	2.840	7933067	484058	94.853	91.990
5	3.852	71494	4614	0.855	0.877
6	5.162	15556	706	0.186	0.134
7	6.504	57660	1384	0.689	0.263
Total		8365531	526210	100.000	100.000

Sample C13: *Morinda citrifolia*



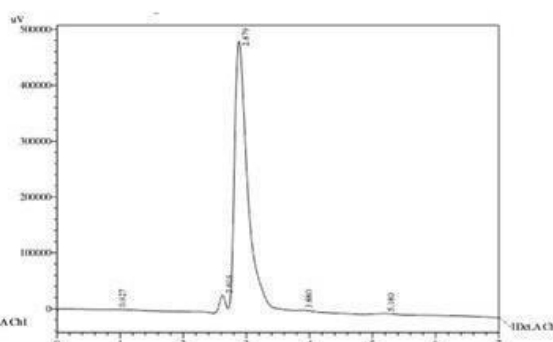
Peak#	Ret. Time	Area	Height	Area %	Height %
1	2.558	191717	30812	2.605	6.012
2	2.818	7120139	479655	96.732	93.593
3	3.937	11090	928	0.151	0.181
4	5.087	3586	158	0.049	0.031
5	6.371	34181	939	0.464	0.183
Total		7360713	512491	100.000	100.000

Sample C14: *Oryza glutinosa*



Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.792	1327	68	0.014	0.013
2	2.553	313242	43979	3.421	8.181
3	2.846	8614826	482900	94.082	89.827
4	3.859	72481	5471	0.792	1.018
5	4.421	16848	818	0.184	0.152
6	5.152	45716	2114	0.499	0.393
7	6.305	92275	2240	1.008	0.417
Total		9156715	537590	100.000	100.000

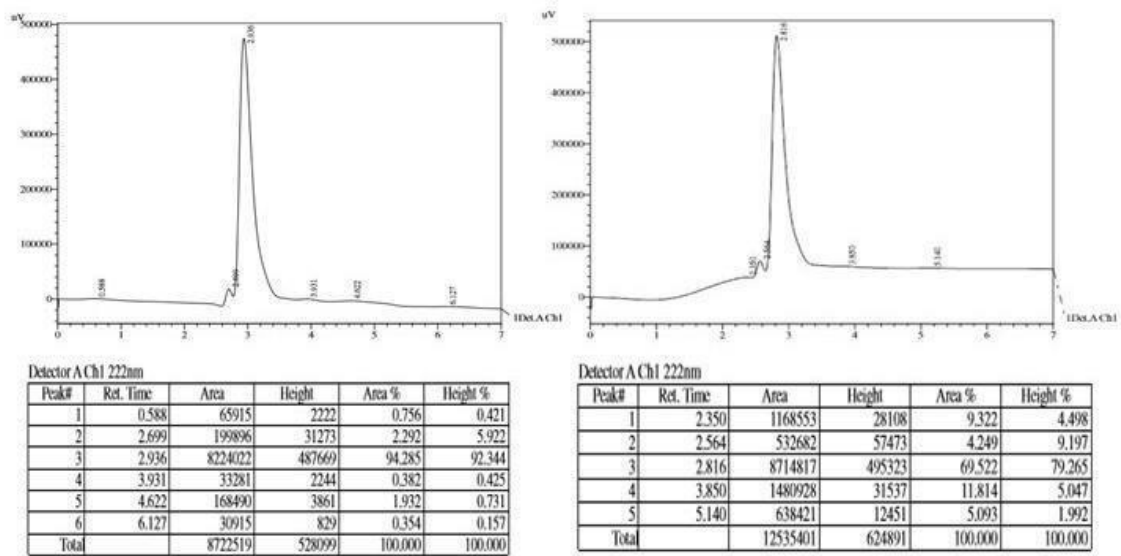
Sample C15: *Lea indica*



Peak#	Ret. Time	Area	Height	Area %	Height %
1	0.927	21561	742	0.281	0.142
2	2.619	209902	31932	2.739	6.093
3	2.879	7369570	487966	96.152	93.115
4	3.880	20203	1481	0.264	0.283
5	5.180	43224	1928	0.564	0.368
Total		7664461	524049	100.000	100.000

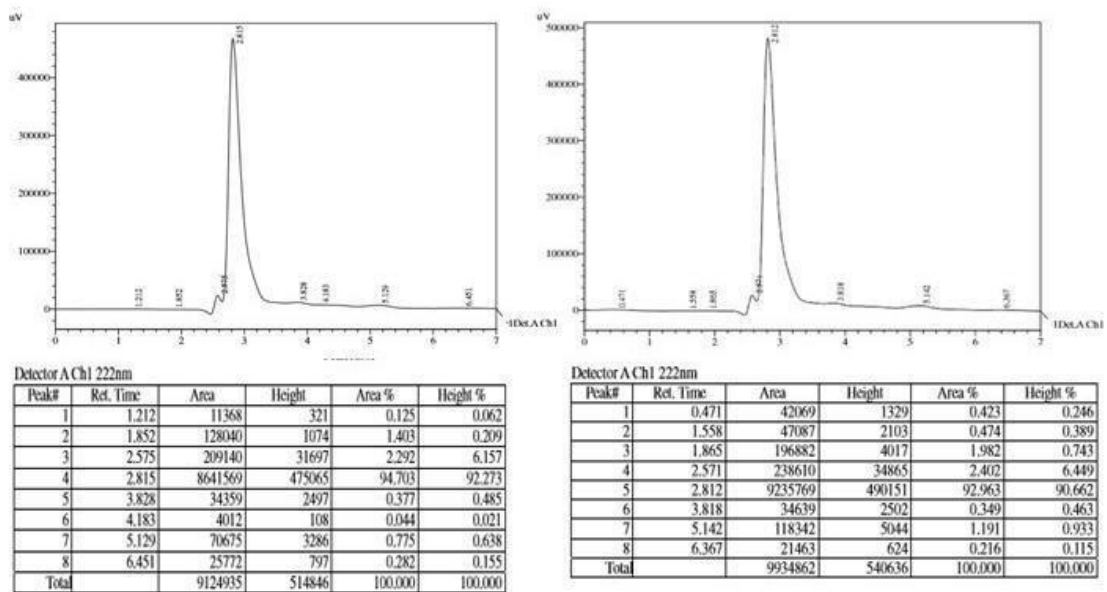
Sample C16: *Vernonia arborea*

Figure 0.9: Selected bioactive compounds detected in the sample (soack in Dichloromethane); Sample C13, C14, C15 and C16



Sample C17: *Trema cannabica*

Sample C18: *Senna alata*



Sample C19: *Lindernia diffusa*

Sample C20: *Citrus aurantifolia*

Figure 0.10: Selected bioactive compounds detected in the sample (soak in Dichloromethane); Sample C17, C18, C19 and C20